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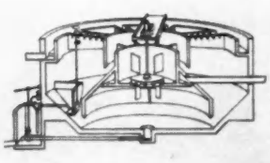

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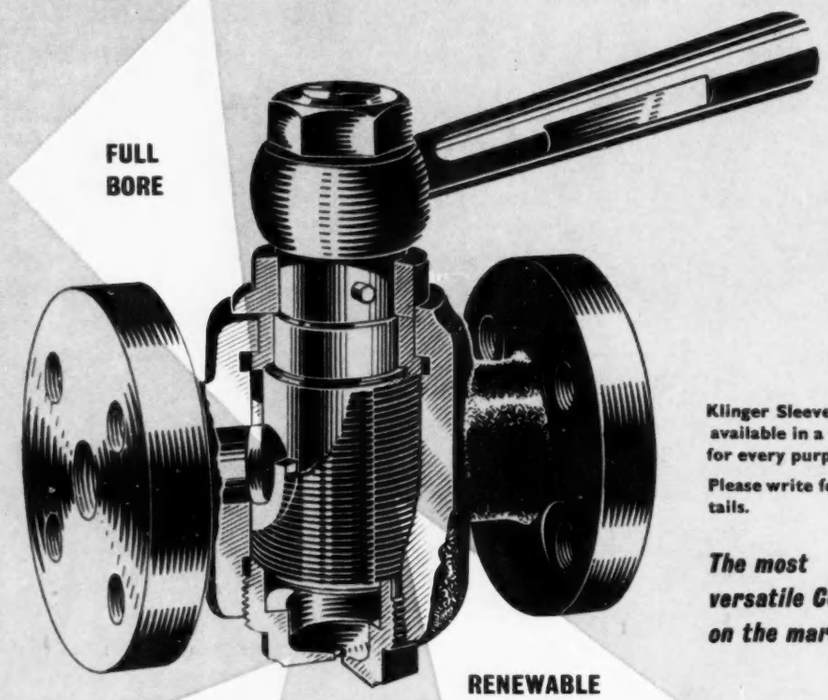

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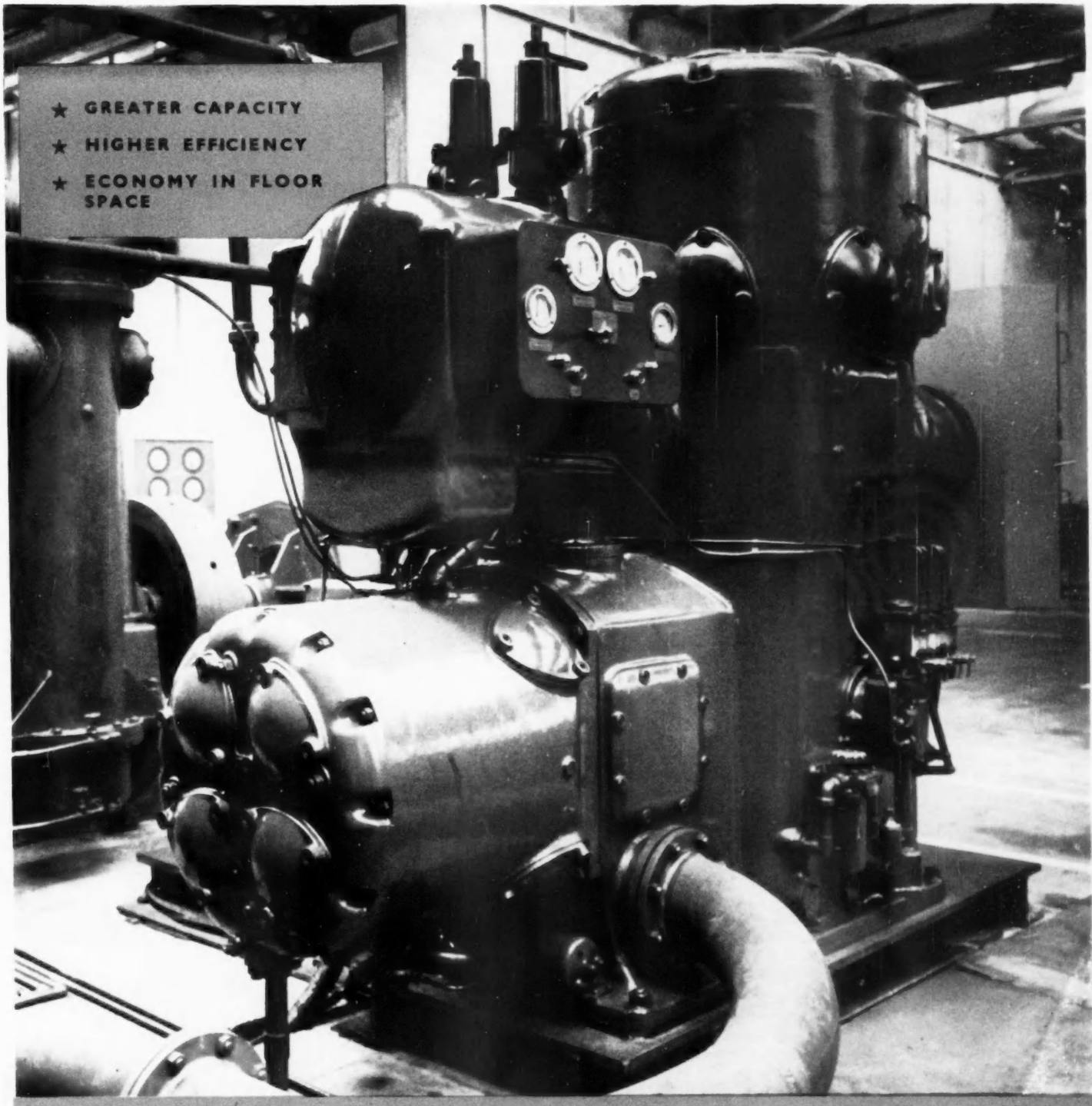

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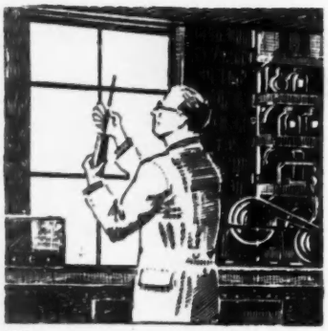

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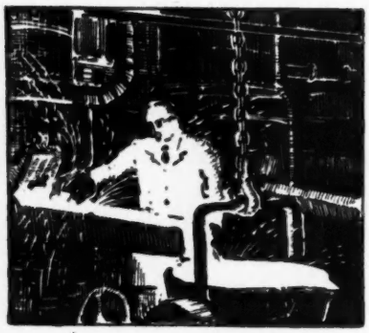

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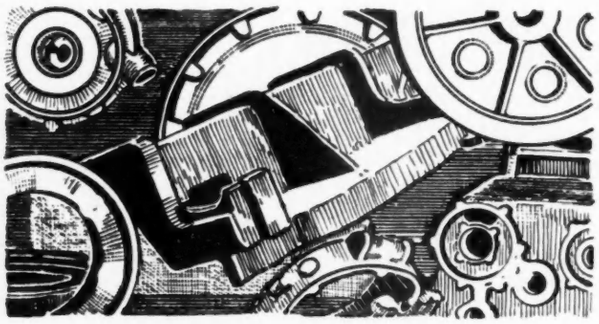

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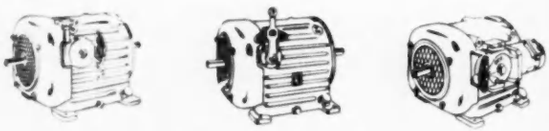

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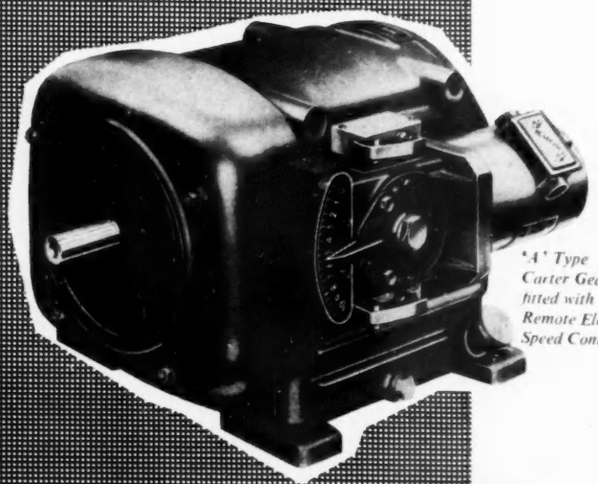

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Contents

146 Metals and Materials

Reinforced Plastic has Great Strength

Fuel Additive prevents Fouling and Sludge, Hose and Ducting better with Polyester Fibres, Phosphating and Degreasing in one Emulsion Bath, New Neoprene Latex and Hypalon Rubber

151 Construction

Road Plans by Air Survey and Computer

Shell Structure Techniques, European Course in Sanitary Engineering, Painting Asbestos Cement, Blast Screen for Jet Airliners, Tattersall's New Stand at Ascot

157 New Plant and Equipment

Horizontal Borer, Fan Heater, Frequency Meter, Thread Cutter, Bench Grinder, Motor Starter.
Physical Society Exhibition: Speed Indicator, Potentiometer, Extensometer, Oscilloscope, Portable Monitor, Pumping Group, Force Balance Unit, Map Maker, Angle Transmitter

162 Design

Strip Winding for High Pressure Vessels

Lightweight Passenger Stairway, Picture Page, Silicon Rectifier, Range of Outboard Motors, Gondola Ski Lift in Canada

168 Research and Development

The Technical Problems of Broadcasting: Part 3—Linking the Television Network
By J. C. Gallagher

High Speed Feed for Hydraulic Press, Mass Spectrometer for Heavy Atomic Nuclei

172 Production

Reeling Made Safer by Automatic Feeding, Defects in Welds, Automatic Control Simulator, Plastics Solve Production Problem, Forge Modernisation, Guided Electric Trucks, Beet Sugar Plant, Oxygen Steelmaking Plant, Gear Hobs Restandardised

174 Operation and Maintenance

Making Air Fit to Breathe

Preserving Documents by Film Coatings, Bottled Gas for Industrial Power, Fifty Years of Electricity Regulations

145 Impact

153 Human Element

161 Companies

171 Marketing

Special Articles

154 Dugapur: A Plant for India's Growth

176 Outlook 1960—Heavy Electrical Plant, Domestic Appliances

156 Automobile Review

Mechanical Efficiency of Piston Engines
By Gordon Wilkins

159 Atomic Review

Testing Space to Spare

180 At Home

House Heating by Gas

148 Plain Words

148 Letters to the Editor

Britain's Railways
Andrew Harkess
NSU-Wankel Engine
J. R. J. Dyke
Stereophonic Reproduction
D. E. L. Shorter
Car Designs for High Speed
G. W. Kelland
Company Taxes Aid Russia
J. B. Aldred
Welding Thick Plates
W. C. Holliday

149 Events in Advance

165 Publications

On the Shelf
By Frank H. Smith
The Physical Chemistry of Steelmaking
Kern-Wissenschaft und-Technik.
Creep of Engineering Materials
Visual Problems of Colour
New Books and Trade Publications

Cover Picture

Maintenance engineer adjusting the master gear-box on the PLUTO coarse control arm drive equipment (*Nurnberg photograph for* ENGINEERING.)

Subsription Rates: Editorial page 180

Index to Advertisers: Overleaf

Engineering Appointments Section: Facing Editorial page 160

Advertisers in 'Engineering' this week

	PAGE
Arbuckle, Smith & Co., Ltd.	54
Associated Electrical Industries, Ltd.:	
Heavy Plant Division	41
Transformer Division	35
Atlas Copco, A.B. (Sweden)	34
Aurora Gearing Co. (Wilmot North) Ltd.	56
Babcock & Wilcox, Ltd.	17
Barimar, Ltd.	13
Booth, Joseph, & Bros.	30
Braby, F., & Co., Ltd.	62
Bristol Siddeley Engines, Ltd.	40
British Electrical Repairs Ltd.	15
British Ermeto Corpn., Ltd.	9
British Paints, Ltd.	38
British Steam Specialties, Ltd.	56
British Steel Founders Association	46
British Twin Disc, Ltd.	38
Broom & Wade, Ltd.	*Wrapper* V
Brown, D. Corporation (Sales) Ltd.	25
Butterfield, W. P., Ltd.	14
C.A.V., Ltd.	*Wrapper* II
Carruthers, J. H., & Co., Ltd.	42
Carter Gears, Ltd.	*Wrapper* VI
Chapman & Hall, Ltd.	4
Clyde Blowers, Ltd.	28
Clyde Crane & Booth, Ltd.	30
Clyde Crane & Eng'g. Co.	30
Cohen, G., Sons & Co., Ltd.	63
Conveyor & Elevator Co. (1936) Ltd.	10
Cork Mfg. Co., Ltd.	33
Cowans Sheldon & Co., Ltd.	12
Crofts (Engineers) Ltd.	47
Dawson & Downie, Ltd.	5
Editorial Contents	1
Elliston, Evans & Jackson, Ltd.	52
Farrar Boilerworks, Ltd.	52
Fawcett Preston & Co., Ltd.	14
Fenner, J. H., & Co., Ltd.	53
Ferodo, Ltd.	31
Fife Forge Co., Ltd.	15
Firth, Thos., & John Brown, Ltd.	49
Firth Brown Tools, Ltd.	23
General Descaling Co., Ltd.	48
General Electric Co., Ltd.	52
Glover, Wm. J., & Co., Ltd.	36
Goodyear Tyre & Rubber Co. (G.B.) Ltd.	32
Grafton Cranes, Ltd.	60
Harcourt, D., Ltd.	61
Harland Eng'g. Co., Ltd.	60
Harland & Wolff, Ltd.	56
Heap, J., & Co., Ltd.	8
Hilton, R. B., Ltd.	19
Holland, B. A., Eng'g. Co., Ltd.	13
Hopkinsons, Ltd.	6
Hudswell, Clarke & Co., Ltd.	15
Imperial Aluminium Co., Ltd.	26 & 27
Imperial Chemical Industries, Ltd. (Metal Degreasing)	57
Ironsides Lubricants, Ltd.	50
Jackman, J. W., & Co., Ltd.	10
Johnson & Phillips, Ltd.	22
Keeton Sons & Co., Ltd.	44
Kitchen & Wade, Ltd.	8
Klinger, R., Ltd.,	*Wrapper* IV
Leigh, W. & J., Ltd.	*Wrapper* III
Levy, B., & Co. (Patterns) Ltd.	50
Lincoln Electric Co., Ltd.	21
Londex, Ltd.	38
Low Moor Alloy Steelworks, Ltd.	20
McGraw-Hill Publishing Co., Ltd.	4
Manchester Furnaces, Ltd.	50
Marsden, S., & Son, Ltd.	52
Marshall, Fleming & Co., Ltd.	52
Mek-Elek Eng'g., Ltd.	10
Melbro Machine Tool Co., Ltd.	60
Metallic Valve Co., Ltd.	39
Morris, B. O., Ltd.	58
Moss Gear Co., Ltd.	*Wrapper* VIII
Murex Welding Processes, Ltd.	51
Newbury Diesel Co., Ltd.	38
Norris Bros., Ltd.	15
Opperman, S. E., Ltd.	64
Painut Co., Ltd.	5
Parmiter Hope & Sugden, Ltd.	24
Parsons, C. A., & Co. Ltd.	18
Paterson Eng'g. Co., Ltd.	*Wrapper* III
Pool, J. & F., Ltd.	10
Positive Lock Washer Co., Ltd.	10
Reavell & Co., Ltd.	8
Renshaw Foundry, Ltd.	*Wrapper* VI
Reyrolle, A., & Co., Ltd.	43
Richardsons Westgarth (Hartlepool) Ltd.	16
Robson, Geo., & Co. (Conveyors) Ltd.	38
St. Georges Engineers, Ltd.	61
Sankey Green Wire Weaving Co., Ltd.	50
Savery Thomas, Pumps, Ltd.	*Wrapper* VII
Scriven Machine Tools, Ltd.	56
Sealdraught, Ltd.	13
Serck, H. O., Ltd.	56
Simmonds Aerocessories, Ltd.	55
Smith, H., & Co. (Possil) Ltd.	59
Smith & McLean, Ltd.	61
Smiths Industrial Instruments, Ltd.	4
Stephens Belting Co., Ltd.	*Wrapper* VII
Sturtevant Eng'g. Co., Ltd.	7
Taylor & Hubbard, Ltd.	5
Teddington Industrial Equipment, Ltd.	45
Terry, H., & Sons, Ltd.	32
Visco Eng'g. Co., Ltd.	2
Vokes, Ltd.	37
Wailes, G., & Co. Ltd.	50
Wailes Dove Bitumastic, Ltd.	29
Taylor & Hubbard, Ltd.	5
Wellman Bibby Co., Ltd.	28
Wellman Smith Owen Eng'g. Corp., Ltd.	54
White, R., & Sons (Engineers) Ltd.	2
Woodward Governor Co.	11
Yarrow & Co., Ltd.	6

Classified: Trade & Technical

Bell, H. (Machine Tools) Ltd.	3
Dyas & Fowle	4
Edwards, F. J., Ltd.	3
Flint & Partners, Ltd.	3
Research Engineers, Ltd.	3
Soag Machine Tools, Ltd.	3
Ward, Thos. W., Ltd.	3

'Engineering' Appointments Section inside Editorial Section

Associated Portland Cement Manufacturers, Ltd.	5
British Transport Docks	1
Denison, S., & Son, Ltd.	1
Esso Petroleum Co., Ltd.	6
General Electric Co., Ltd.	6
Gibbs, Sir A., & Partners	3
Imperial Chemical Industries, Ltd.	2 & 5
Imperial Smelting Corpn., Ltd.	1
Kellogg International Corpn., Ltd.	2 & 4
Lucas, J. (Electrical), Ltd.	3 & 4
Shell International Chemical Co., Ltd.	4
Smith & Sons (England), Ltd.	3
Vickers-Armstrongs (Engineers), Ltd.	2
Wellman Smith Owen Eng'g. Corpn., Ltd.	5

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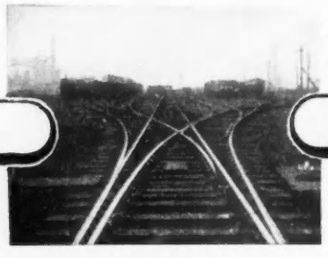

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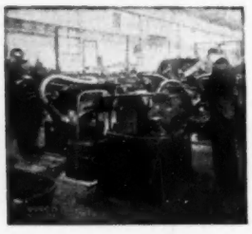

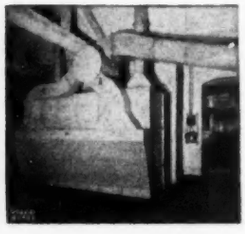

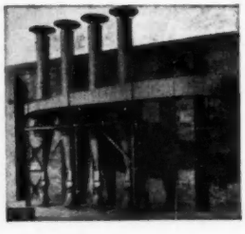

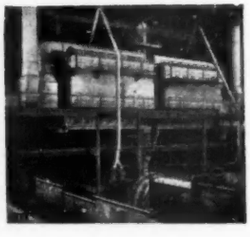

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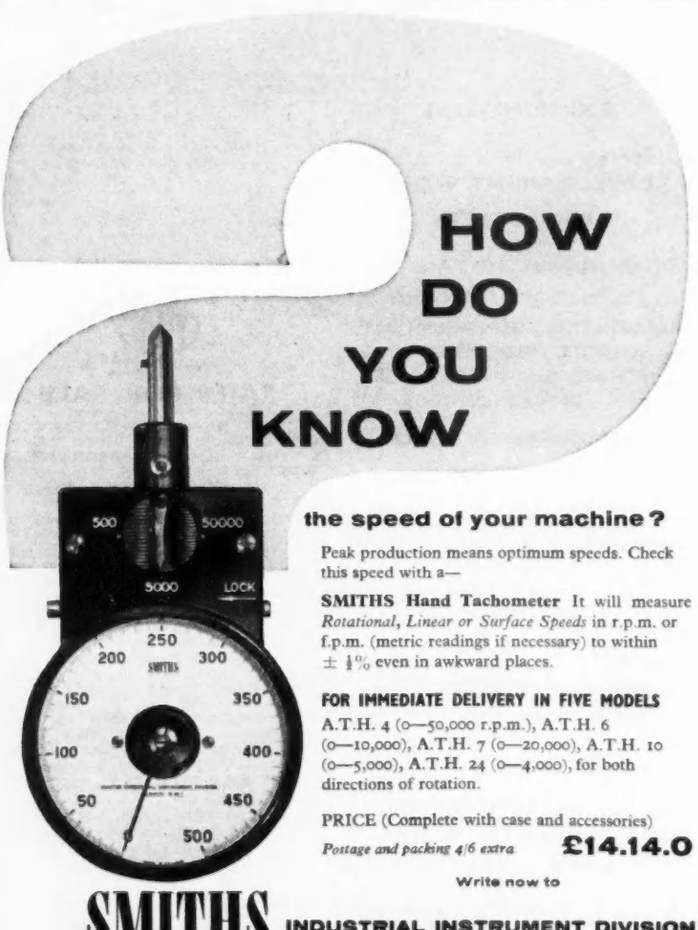

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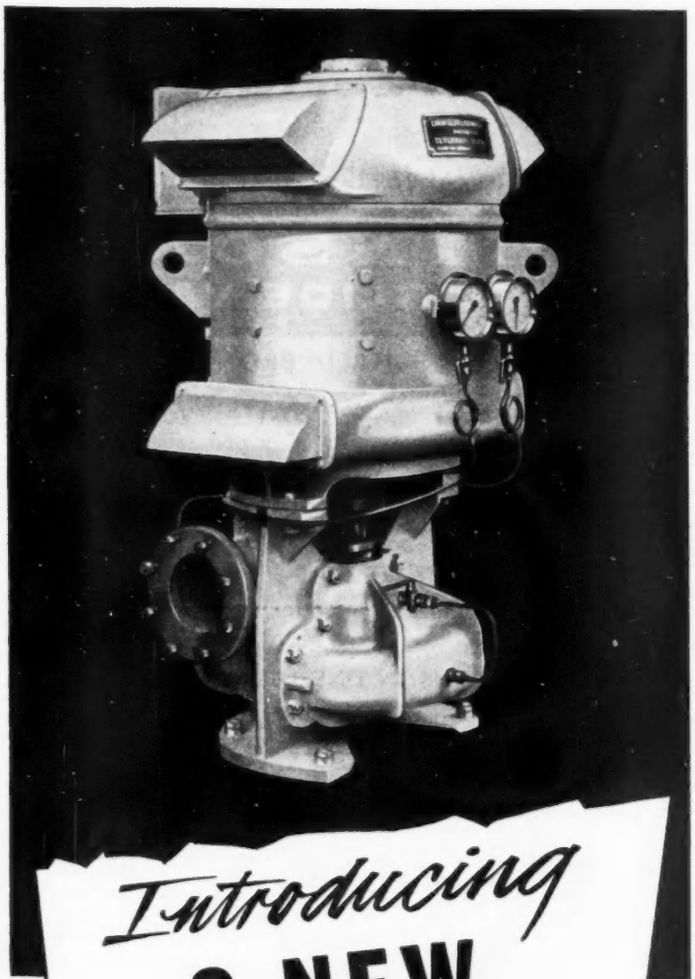

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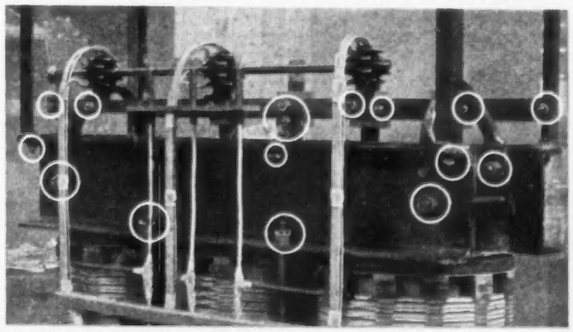

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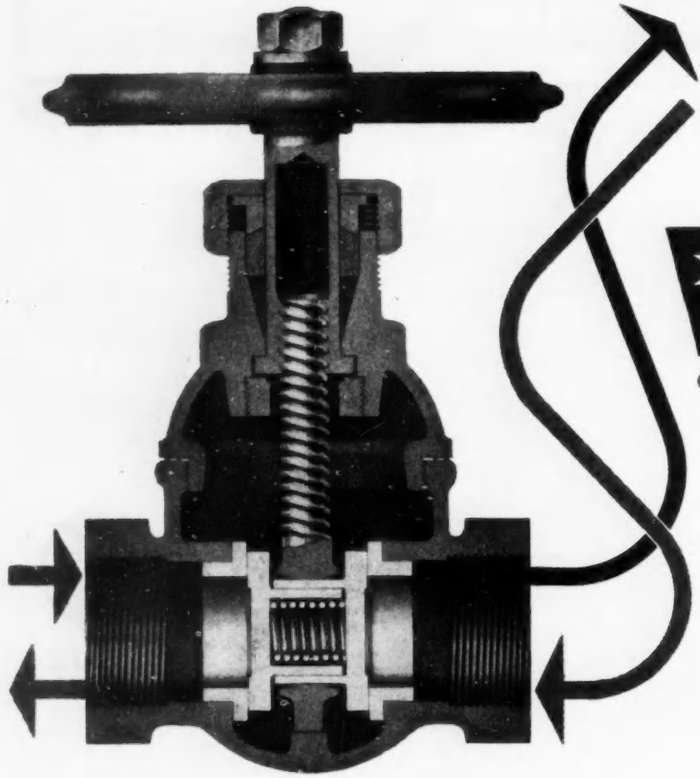

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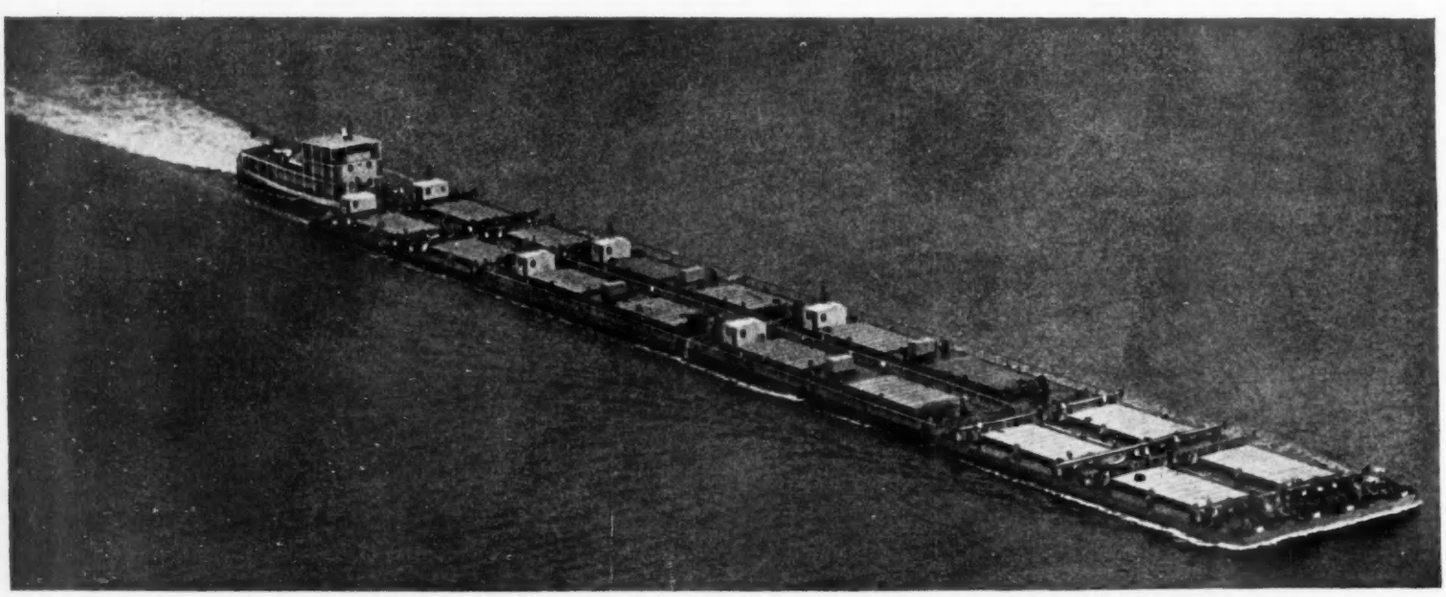

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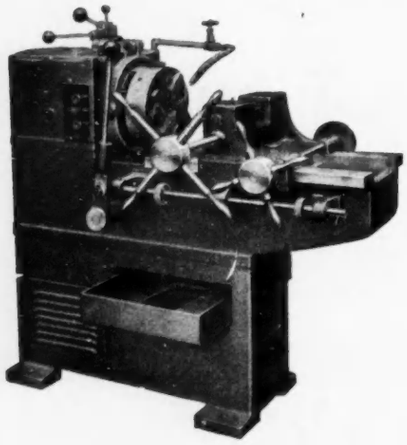

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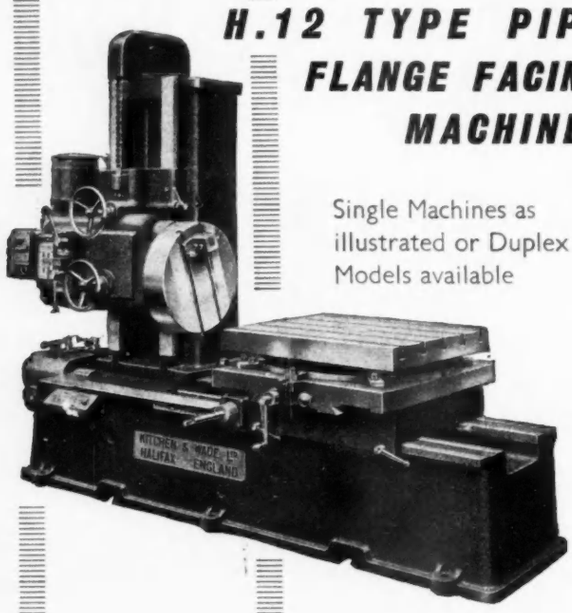

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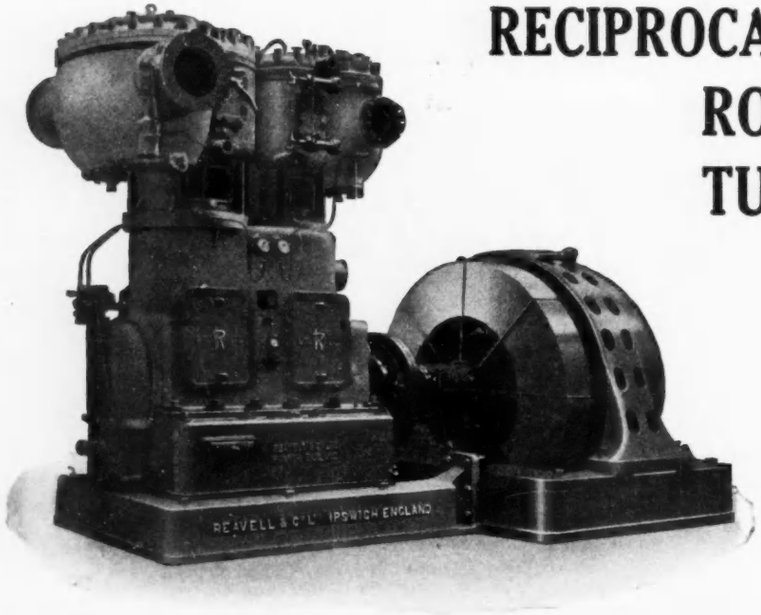

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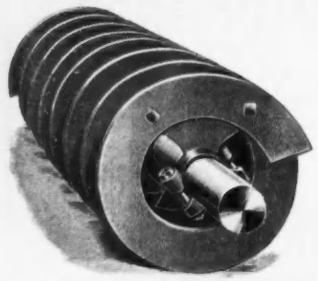

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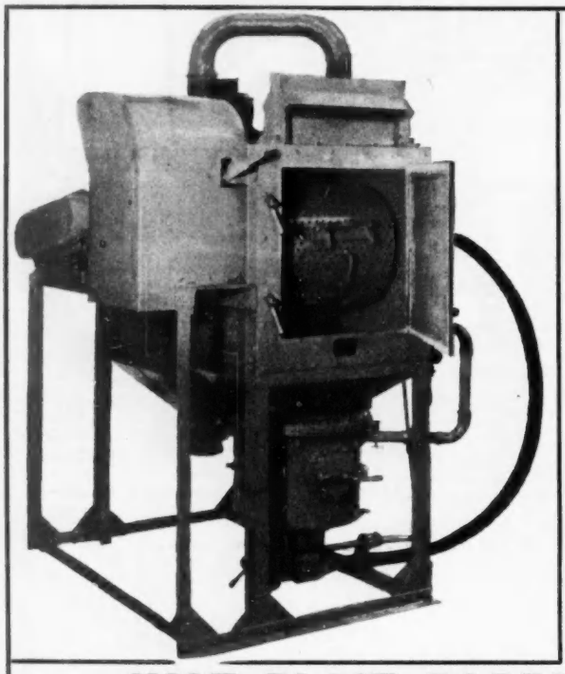

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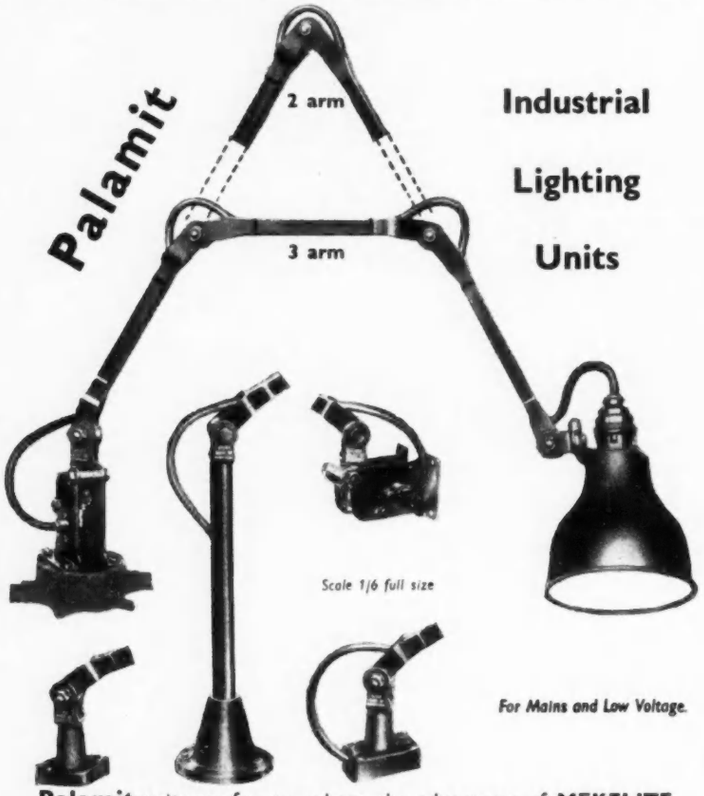

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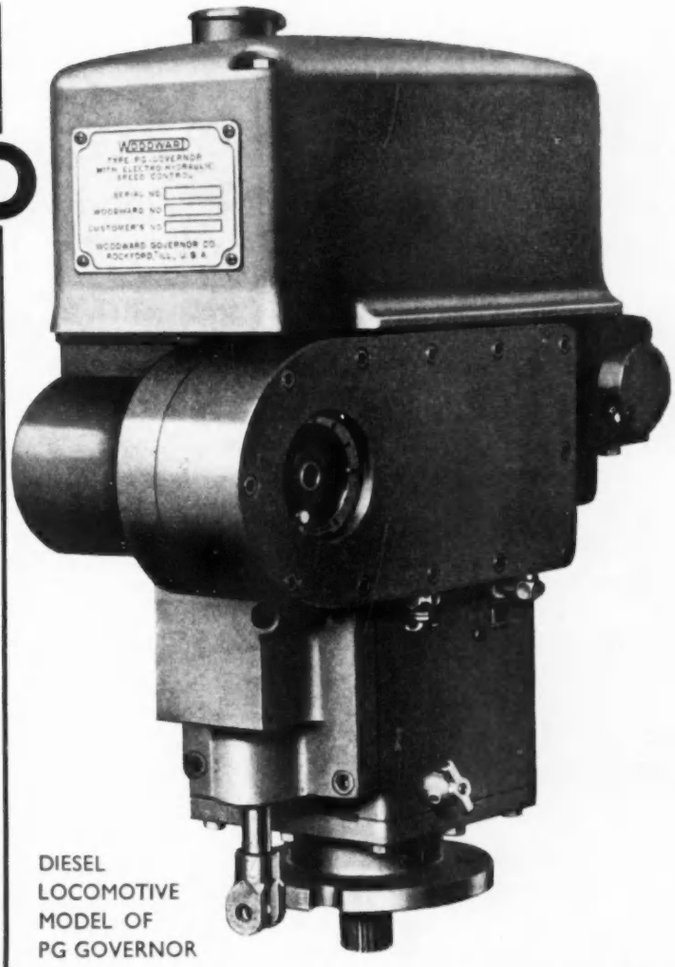

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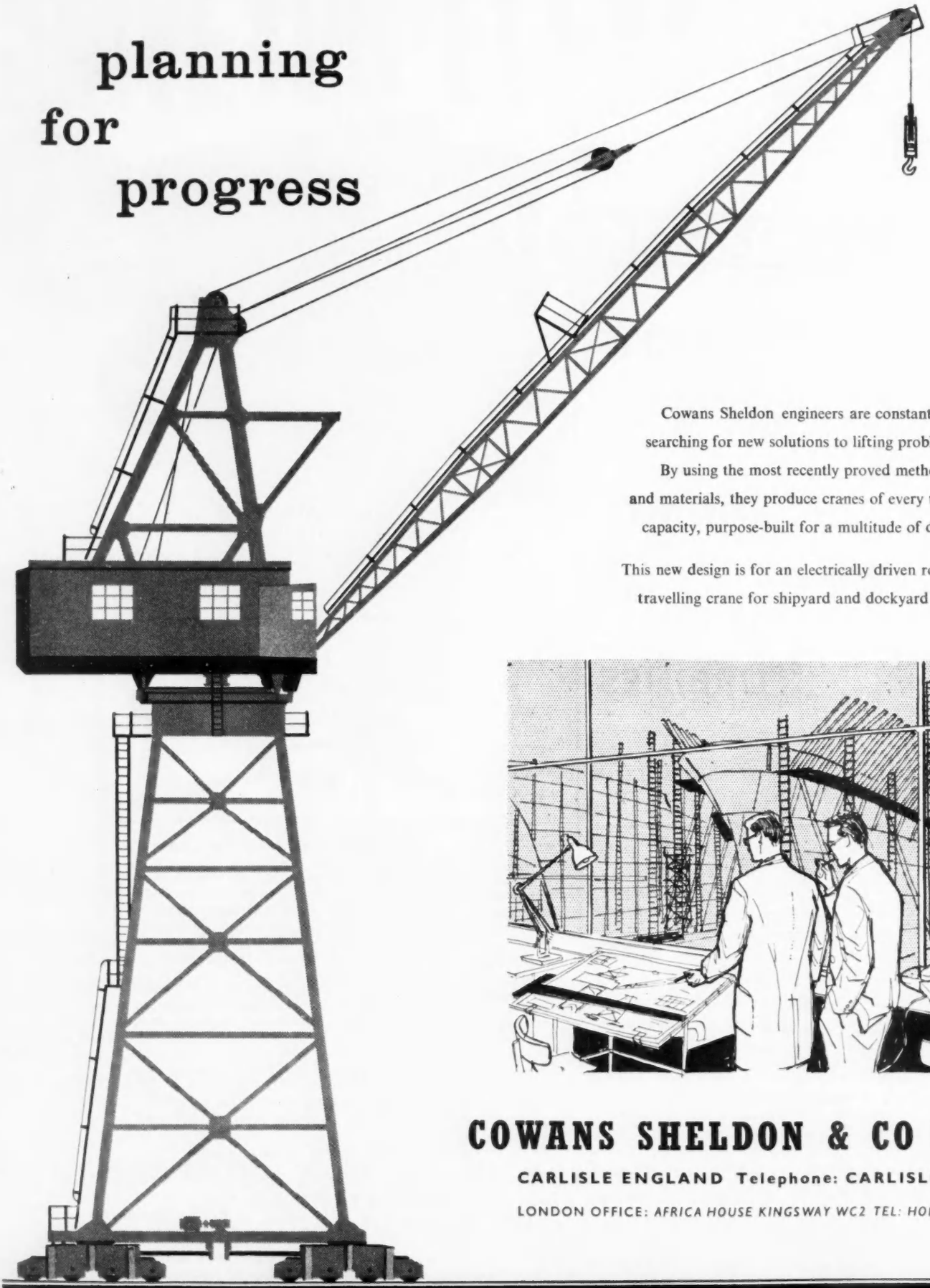

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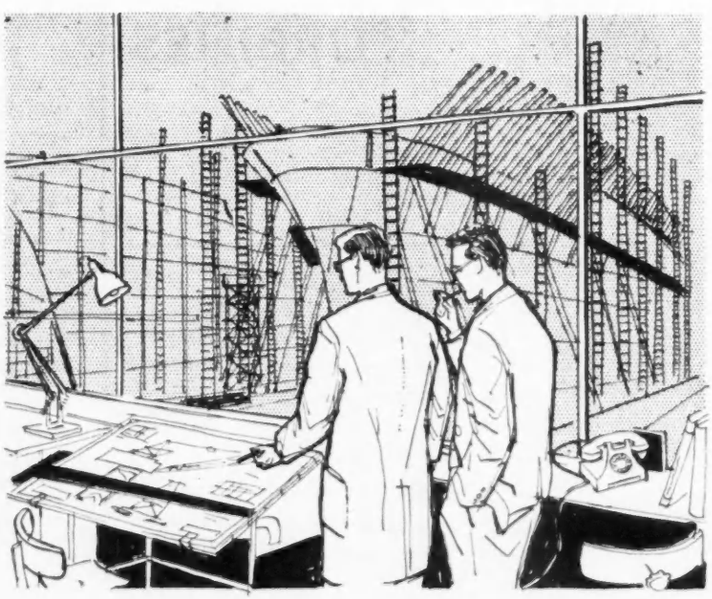

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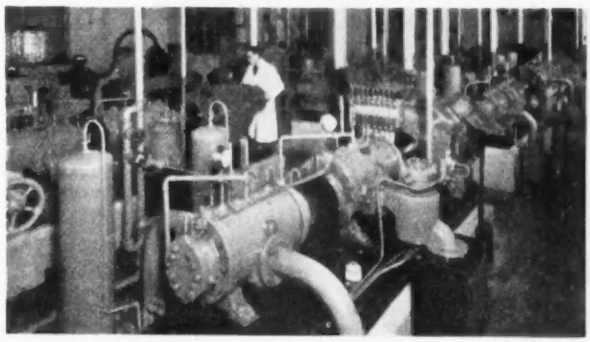

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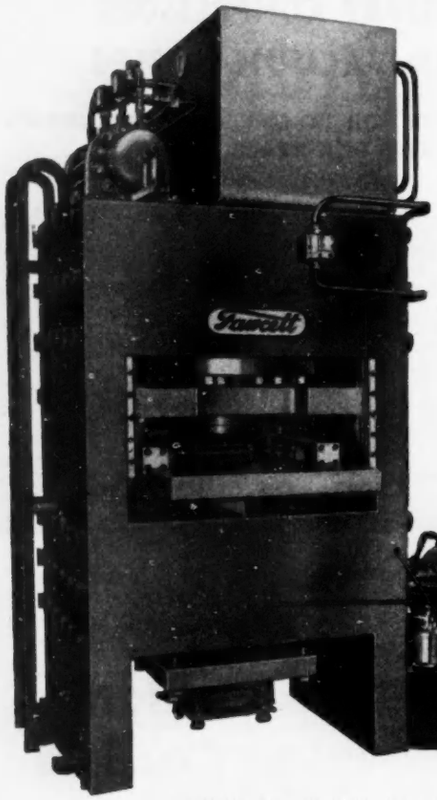

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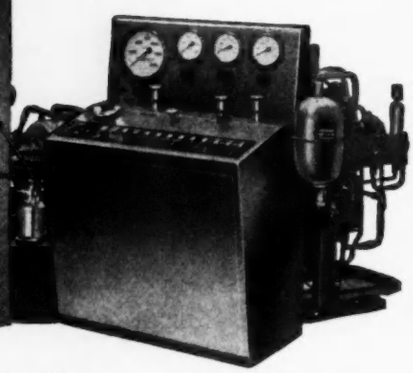

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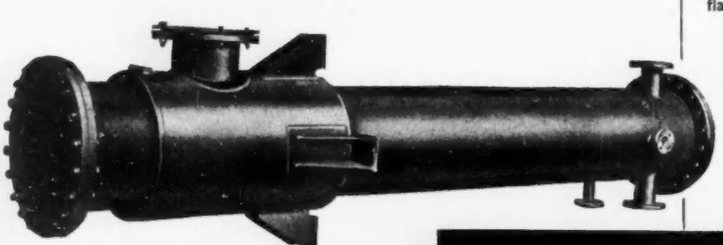

Illustrated on right
50-gallon Mixing Vessel in 18/8/Mo Stainless Steel, 2ft. 3in. I/D by 2ft. 3½in. deep from 14 gauge material, dull polished internally and descaled externally. Provided with 3 angle type supports, 1in. outlet branch and a 10-gauge cover, half of which may be easily lifted off. The vessel contents are agitated by means of two 3in. dia. propeller type stirrers, driven at 1,440 r.p.m. through a ¾in. diameter shaft, by means of a ¼h.p. flameproof motor, suitable for 400/440 volts, 3-phase, 50 cycles A.C. supply. The motor is supported from the side of the vessel by means of a fabricated Mild Steel Bracket.

Illustrated on left:
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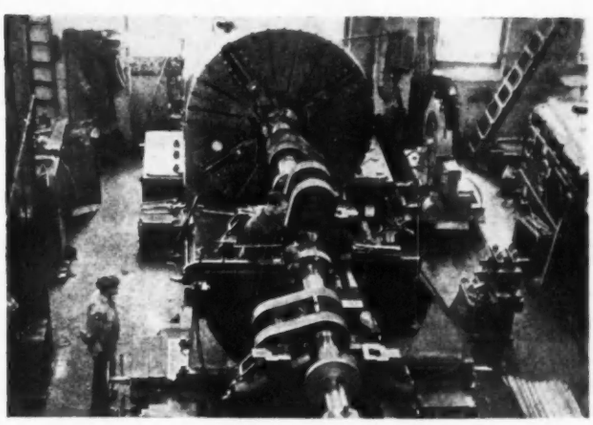

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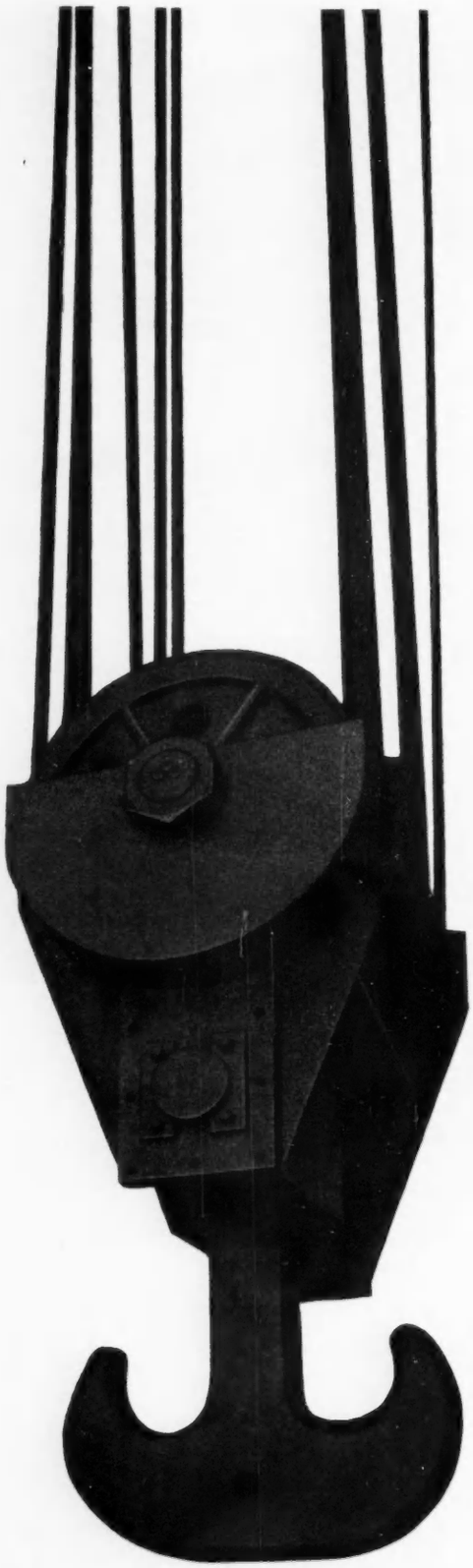

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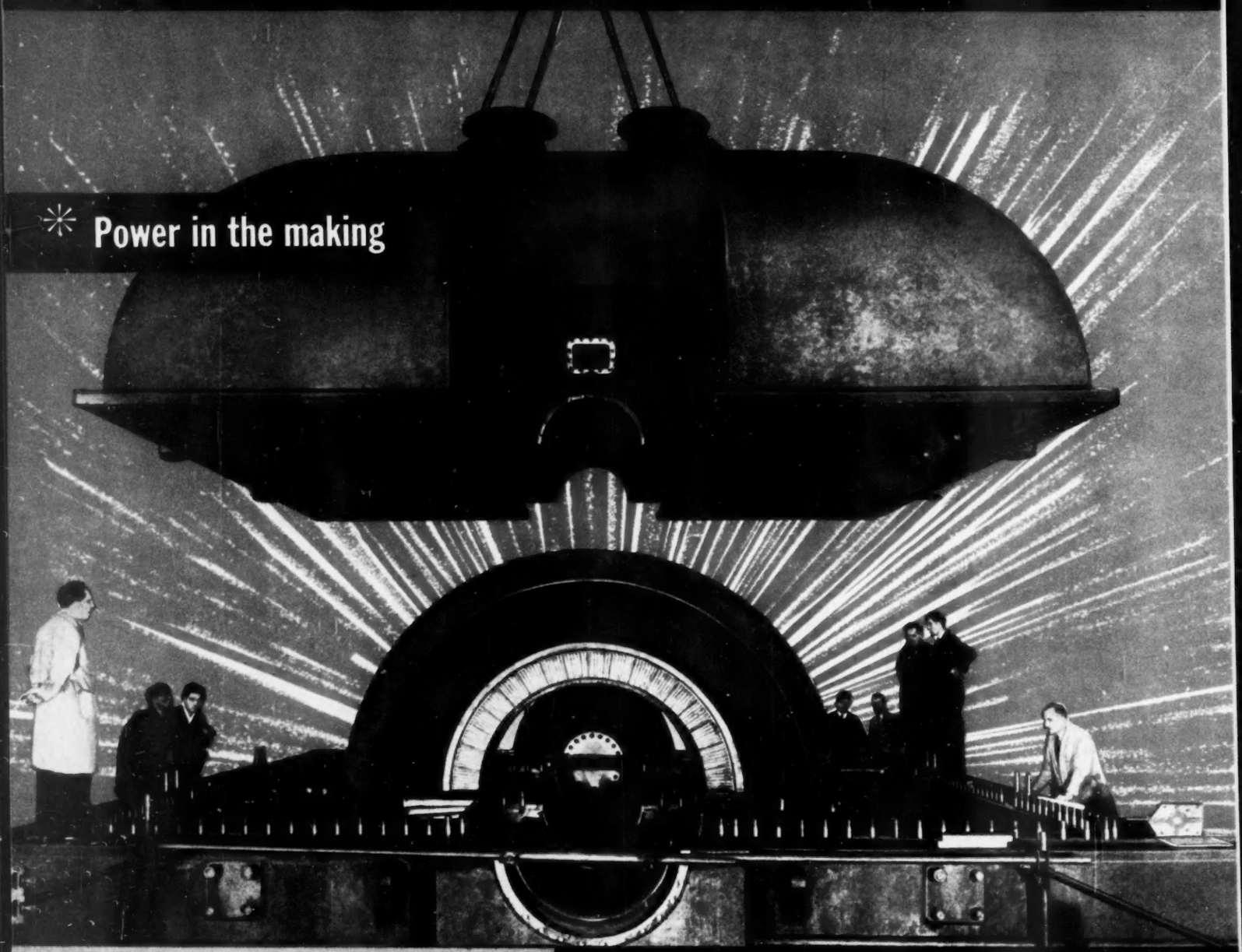

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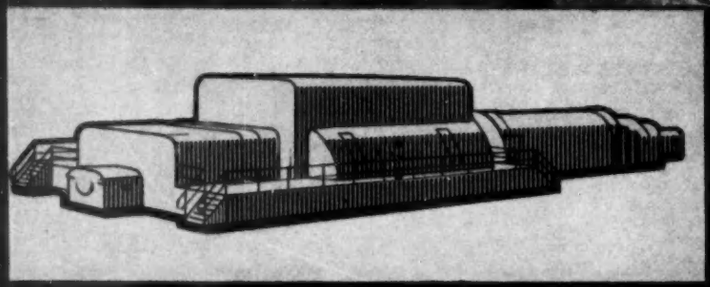

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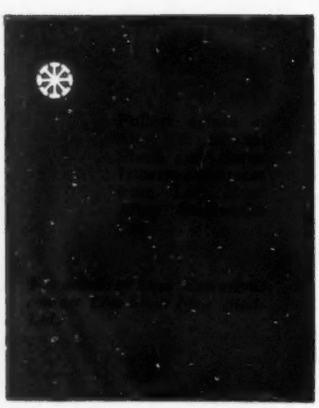

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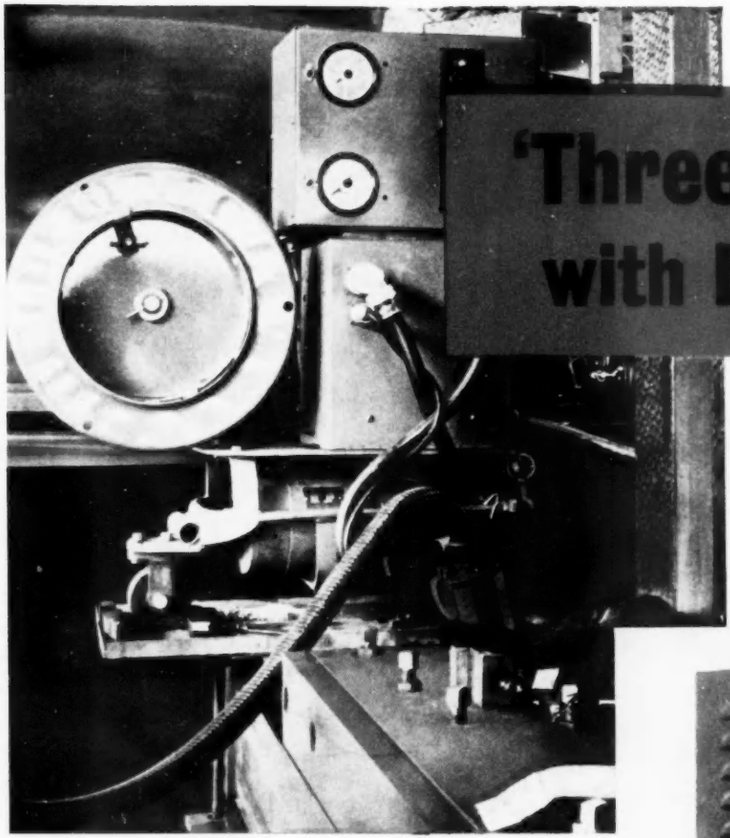
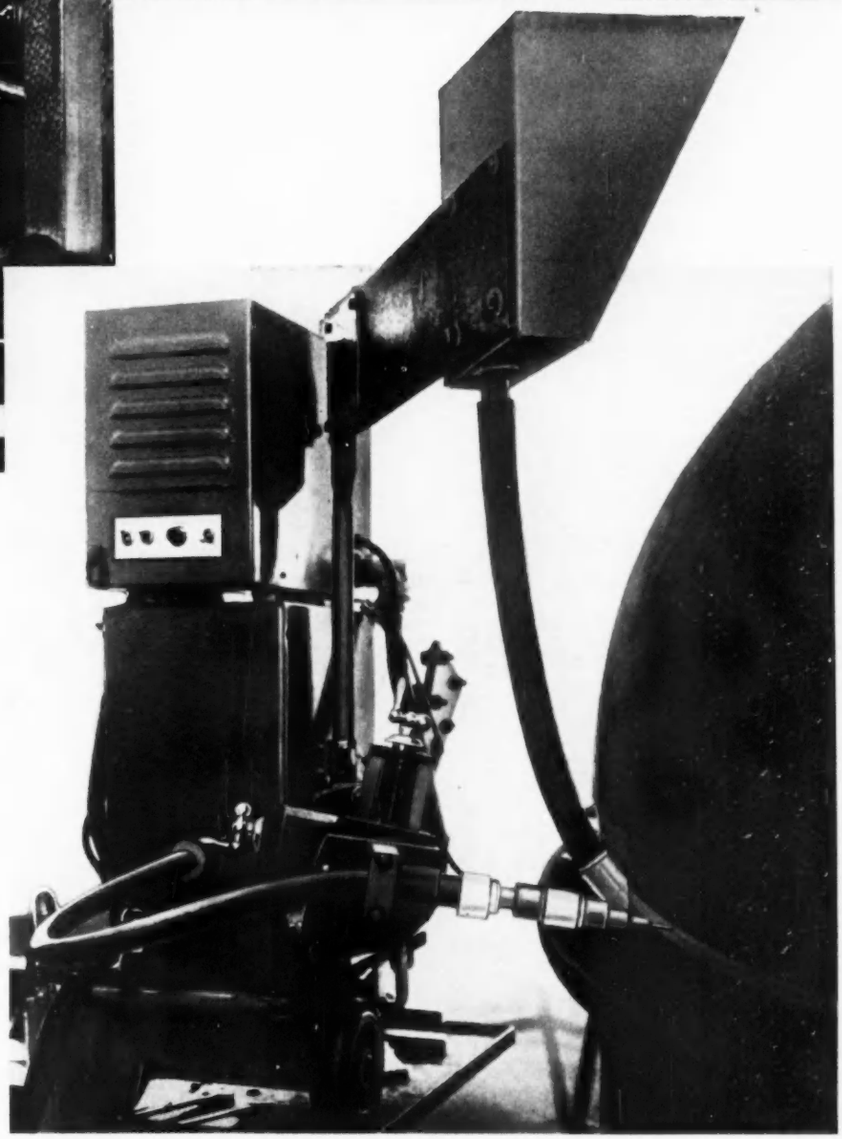


'Three o'clock' welding with LINCOLNWELD



THE LINCOLNWELD Universal Tractor in action at the Derby works of International Combustion Co. Ltd. The illustrations show the Universal Tractor automatically welding in the '3 o'clock' position, a section of one of 4 heat exchangers for The Advanced Gas Cooled Reactor, being built at Windscale, Cumberland, for the United Kingdom Atomic Energy Authority. (Photographs by the courtesy of International Combustion Co. Ltd. and U.K.A.E.A.)

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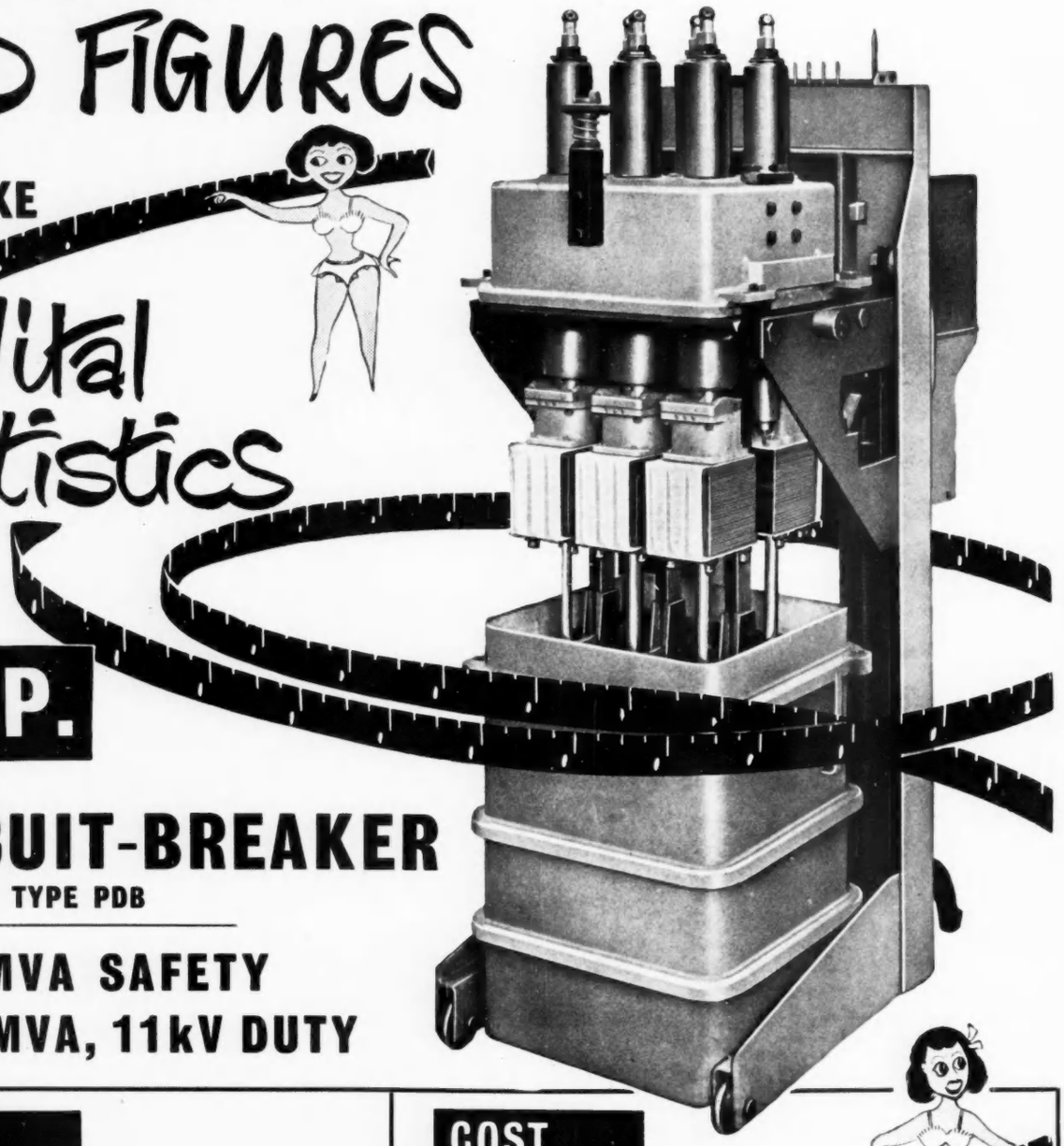

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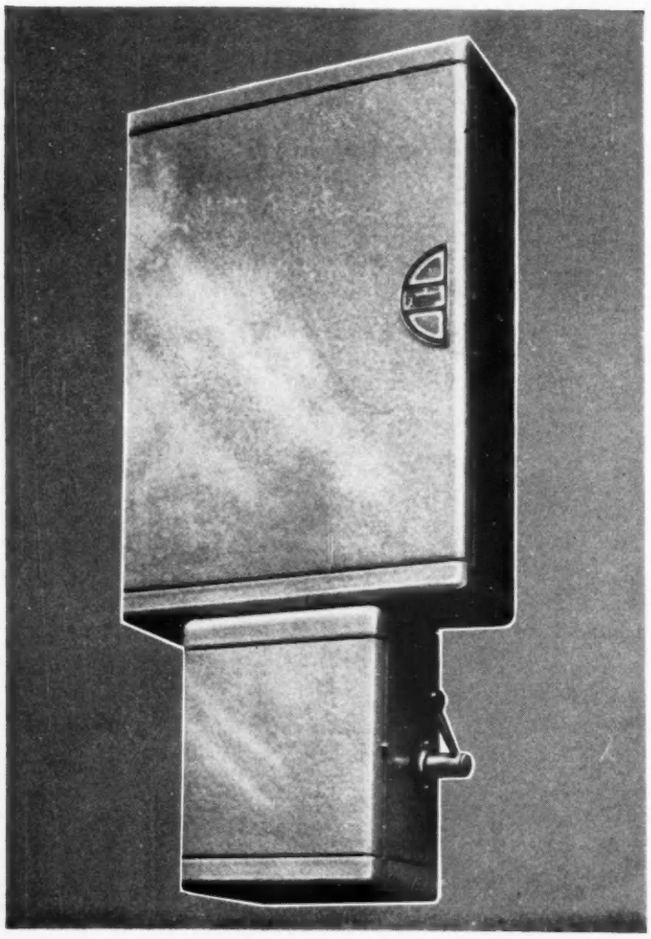

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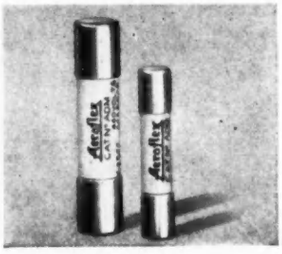

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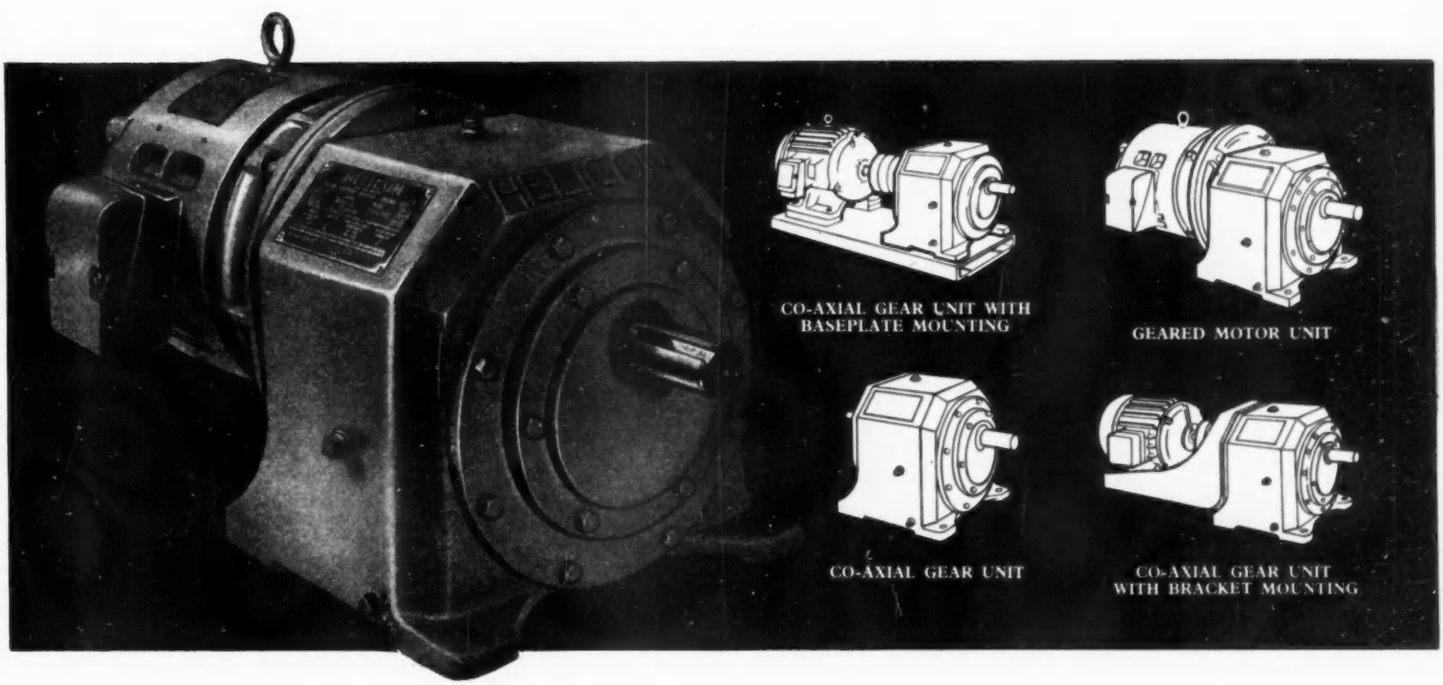
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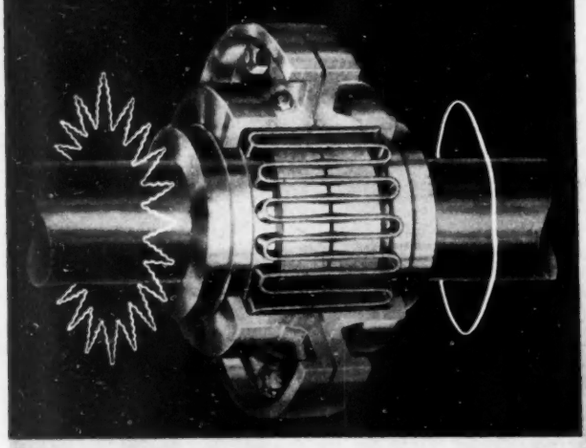

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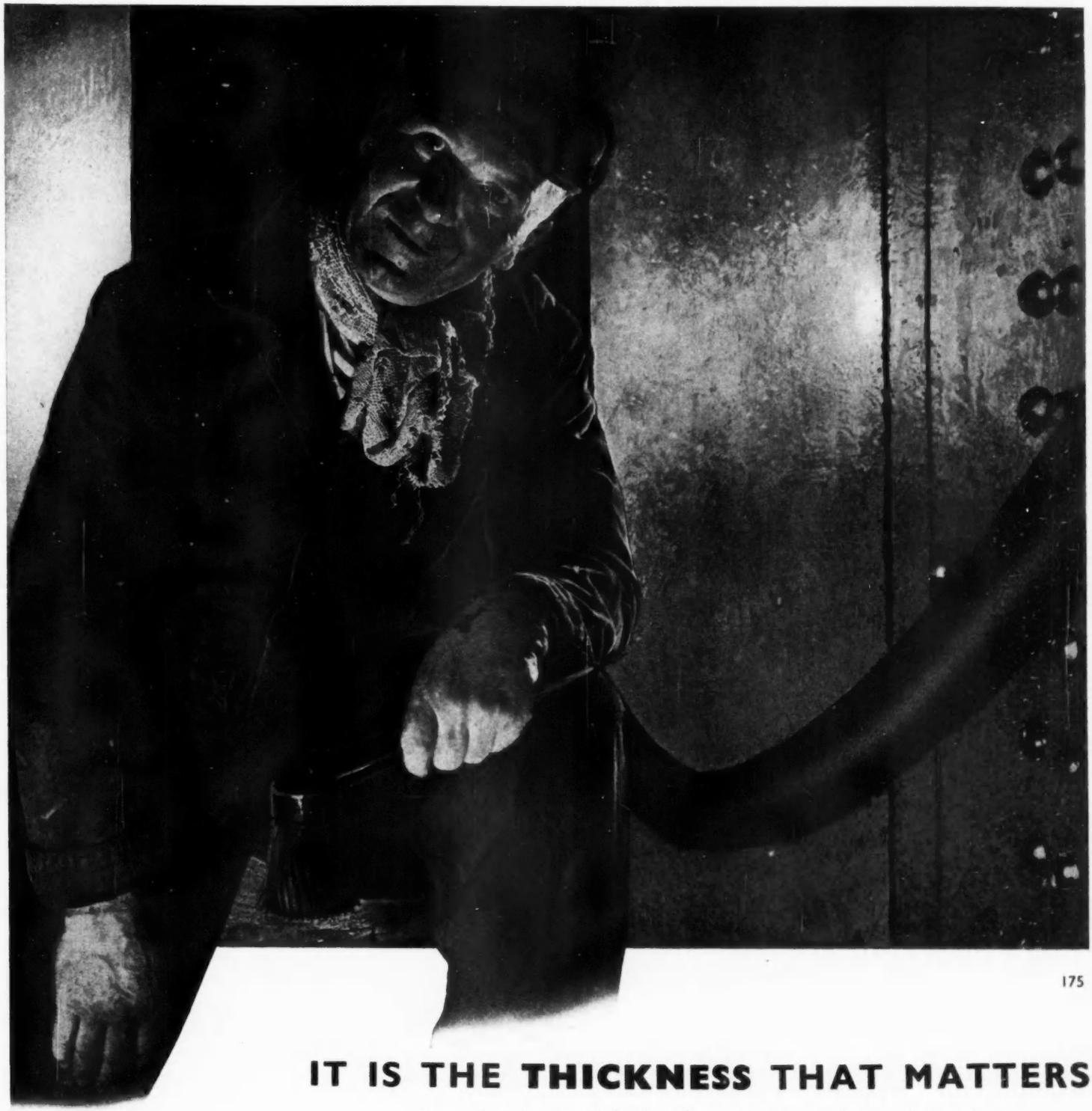

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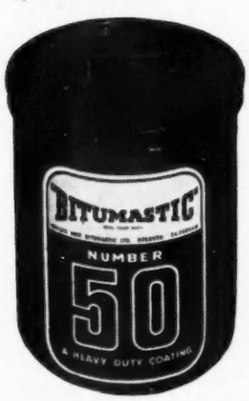
IT IS THE THICKNESS THAT MATTERS



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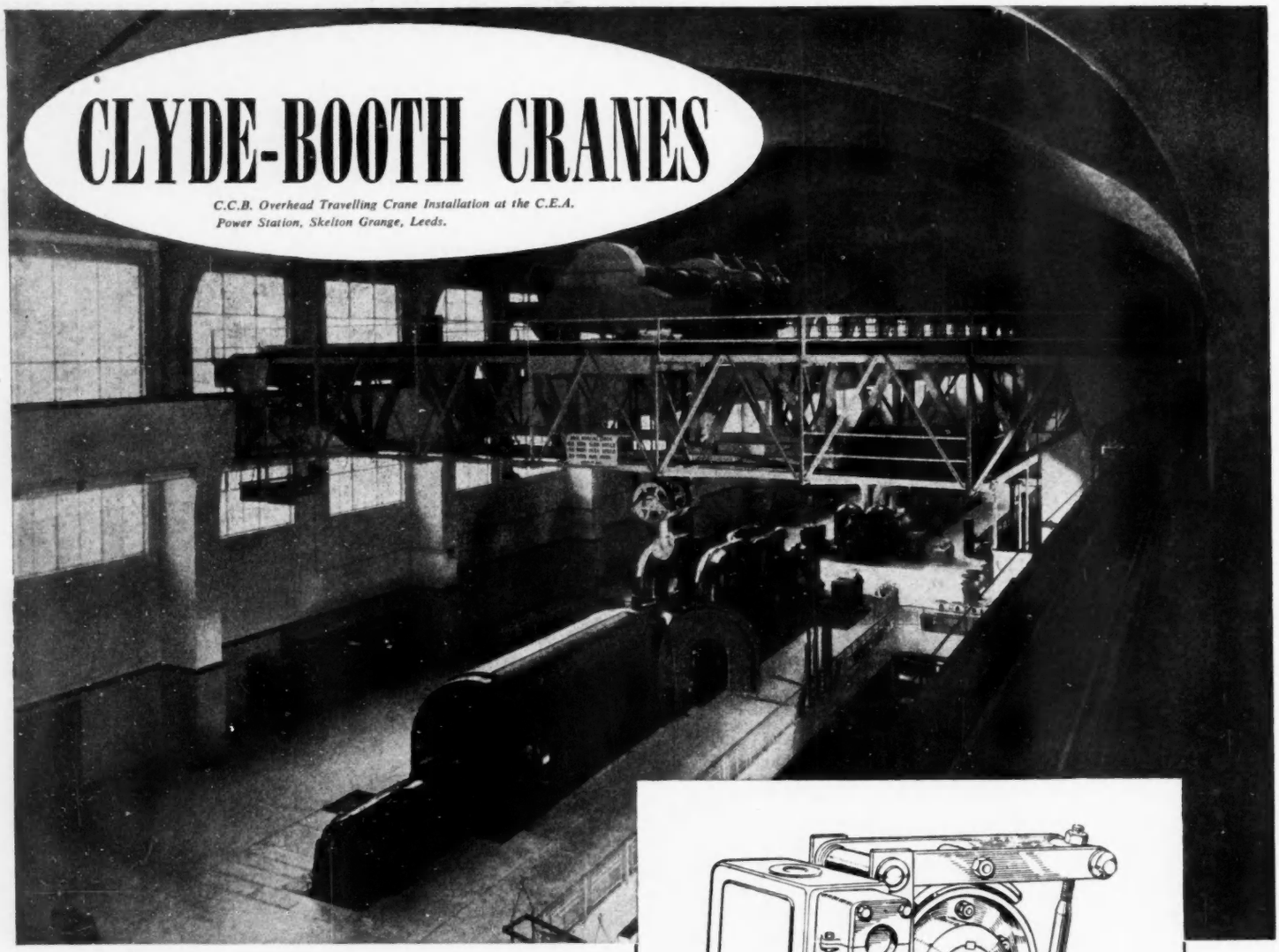

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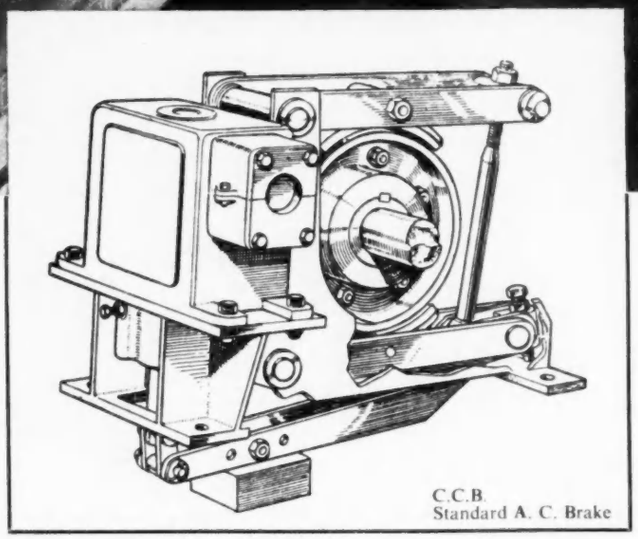

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Standard A. C. Brake

- **Hardened and ground pins working in phosphor bronze bushed links.**
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- **Quick and easy adjustment to compensate for lining wear.**
- **Wide brake drum and shoes provide large friction area.**

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From the Goodyear family tree

A SUCKER FOR WATER WORK

For mines, sewers, foundations — and all lighter duties too — choose Goodyear hose for water suction. Hand-built to exacting specifications, it is really rugged, and highly resistant to crushing and kinking. Reinforcing materials and rubber compounds are carefully selected to suit the service. When you need water suction hose — or any other type of hose — specify Goodyear for longest, trouble-free life. There is a wide range of types and sizes — all from the Goodyear family tree.

* Round steel wire helix supports hose against collapse from suction, yet gives good flexibility.
* Choice of rough or smooth bore, or semi-embedded construction.
* Hose may be supplied externally armoured for delivery service.
* In lengths up to 60 ft., in sizes 4 in. in diameter; and in lengths up to 30 ft., in sizes 4 in. and over.

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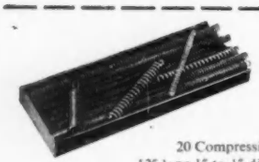
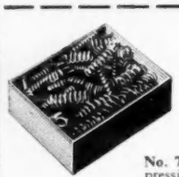
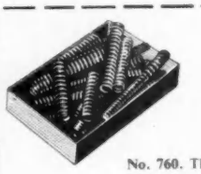


No. 1024 20 Compression Springs. 12" long ⅛" to ½" diam. 24G to 18G suitable for cutting into shorter lengths; and 30 Expansion 1½" to 12" long. 5/32" to ⅞" diam., 22G to 16G. **24/- each.**

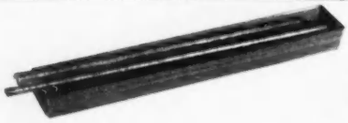


No. 757. Extra Light Compression, 1 gross Assorted, ⅛" to 7/16" diam. ½" to 2½" long. 27 to 19 S.W.G. **15/- each.**

No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



No. 760. Three doz. Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G. ½" to ⅞" diam. **6/6 each.**



No. 761. 1 foot lengths Expansion Springs suitable for cutting into shorter lengths. Assorted diameters from ⅛" to ½" and 24 to 16 S.W.G. **7/6 per box containing 1 dozen lengths.**

No. 762. 1 foot lengths Compression Springs suitable for cutting into shorter lengths. Assorted diameters from ⅛" to ½" and 24 to 16 S.W.G. **4/6 per box containing 1 dozen lengths.**

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ENGINEERING Impact

of Spreading Out the Car Plants

Are the Government swimming against the tide when they persuade the motor car industry to put new factories in areas of comparatively high unemployment—Scotland, South Wales and Merseyside? If the urge to move south is irresistible and infectious among the people of this country, it could be dangerous to make industry subject to political motives.

The British Motor Corporation's announcement last week is part of a splendid example of political and industrial strategy, which includes the steel industry's plans to have Colvilles' new strip mill at Ravenscraig, near Glasgow, ready by 1961-62, and probably further extensions to the sheet capacity of the Steel Company of Wales and Richard Thomas and Baldwins by about the same time. John Summers's plant at Shotton, not far from Merseyside, is currently being expanded; by the end of this year the tonnage of sheet production will be substantially increased. The steel industry seem to have taken the plunge first by deciding to erect the strip mill in Scotland, and their confidence has been taken up by BMC. Other motor-car makers are likely to follow.

With such a powerful lead from the Government and two major industries, many smaller concerns will be encouraged to set up or expand. There will be work for tool firms and others who do subcontracting jobs.

One important step remains to be taken: the area councils for industry, which have been principal instigators in the plans to get more industry into these areas, must give some of their attention to the task of making these areas more pleasant to live in. Glasgow and South Wales must become as well-provided socially and culturally as London if they really want to check the southward movement of population.

Record Exports to America

The achievement of the billion dollar level (£357 million) in United Kingdom exports to the United States is a success, yet at the same time a warning.

In one year alone car exports to the USA have expanded by 40 per cent. This automatically raises the question whether so rapid a rise can be permanent. The home manufacturers are beginning to roll out their "compacts" though nothing the Detroit designers have in mind is as compact as the Morris Minor, the Standard International Triumph Herald or the equivalent Austin.

The German car industry has retained its hard won lead in total production over the British industry. The Italian designers are as prolific as ever and in following the Italianate style British manufacturers are perhaps at the mercy of a sudden change in fashion.

Other of the components that make up the improved export performance in the States are of more gradual growth. Whisky, that long established contributor, rose last year by 8 per cent, clothing by 17 per cent to £5·7 million, a sixth of what the whisky brought home. Less than £4 million in total, shoes jumped in earning by 35 per cent. Toys by 39 per cent.

Britain now stands second only to Canada in the list of exporters to the United States. That we should with efficient salesmanship and the right products do even better in the future is suggested by the remark of Mr. Reginald Maudling, President of the Board of Trade, that our exports "still only represent about one-fifth of one per cent of America's gross national product."

Indian Steel, Production and Persuasion

Durgapur, the state-owned Hindustan Steel Company's new plant, is the biggest single export that British industry has ever sold. Is it likely to lead to repeat orders? The answer is certainly "No" as far as India is concerned. Durgapur is one of three new plants intended to raise India's steel production to 4½ million tons a year by the end of the second Five Year Plan in March, 1961. The other plants are Rourkela in Orissa built by a West German Group including Krupp and Demag, and Bhilai built by the Russians.

Many Americans are particularly worried about the Russian built plant. The United States aid of over one billion dollars poured into India since 1951 has been spread thinly over a wide range of projects. Much of it has gone on Technical Cooperation Mission schemes to start up projects which are handed over to Indian control as soon as possible. In other words American Aid in India is not conspicuous and the Indian masses are unaware of its existence. The Russians on the other hand have concentrated their efforts on the Bhilai Steel Project. Nearly a thousand Russian technicians live in the plant town of Bhilainager and have taken the trouble to get a smattering at least of the languages of the people with whom they live and work. Machinery from 400 different Soviet factories, all clearly labelled, is in use on the site. The plant magazine is said to carry a great deal of Soviet propaganda and the local population is treated to frequent film shows and lectures. In addition over 700 Indian technicians have gone off to Russia for training. It is not surprising therefore that Americans are asking whether Bhilai is an economic or a political undertaking.

Another question is just what India is going to do with so much steel. At present annual demand for steel is about 3·5 million tons. Recently steel stocks have been rising and there have been demands from the steel producers that the planners should help the light engineering and consumer goods industries. Whether steel from the new plants will be competitive in world export markets is not yet known. Certainly India's present costs are above the price of Belgian steel landed in India. But whether Indian steel is used at home or exported the planners have decided that there must be still more of it.

The Third Five Year Plan sets a target of 10 million ingot tons by 1966. Where this will come from is still anybody's guess. One possible source is to expand existing plants. This has already been done in the case of the TATA works at Jamshedpur which has been extended by the American Kaiser Company to a capacity of 2 million tons a year. It is no secret that the Indian Government would like to have an American-built plant to add to its international trio.

of World Bank and British Industry

Concrete example of the intention of leaders in the European Common Market to play a leading part in helping the developing nations is given by the £17 million loan which the Deutsche Bundesbank is making to the International Bank for Reconstruction and Development.

The loan from the Bundesbank, the Central Bank of West Germany, is fully convertible and is the second time the World Bank has been to the Bundesbank for Deutsche Marks.

British Government payments to the World Bank have so far been the two per cent of our subscription, 826 million (almost £10 million) in gold and dollars, and the further 18 per cent, 8234 million (£81 million) in sterling.

The benefits to British industry of World Bank activities are not hard to find. Mr. Eugene Black, the Bank's president, recently pointed out in London that United Kingdom firms have obtained overseas orders, in which the Bank has had a financial hand, worth £140 million, 50 per cent more than the total British Government contribution.

The World Bank has borrowed £20 million on the London money market, the last loan, £10 million, being raised only last December.

Five Per Cent Finesse

Will it prove possible to impose a five per cent Bank rate to take some of the steam out of consumer spending without knocking the stuffing out of the improvement in the sections of the engineering industries producing heavy goods?

For some time the figures have been showing a greater increase in our imports than in our exports. We were running faster but still not catching up with ourselves.

The first significant statements from banks and finance houses suggest that while rates and deposits in consumer hire purchase and credit sales will go up, long term money rates will not rise—yet. On this state of affairs it is possible to say that if the rate falls again after a few months then heavy extra costs will not fall on the producer industries. If the rate stays up then in time they will suffer.

Those companies in the steel industry and elsewhere who have negotiated immense loans with banks and the Finance Corporation for Industry will evidently go on for the time being increasing their interest payments as they draw the money, but not with the added increase of a mark up on the rate.

Official emphasis has been on the domestic aims of the increase. If credit is even slightly squeezed then at least the increase in demand for washing machines, cars and so on will diminish. Perhaps the sales charts will be induced to fall. With the multi-million pound capital schemes of the car industry coming forward the Bank rate rise will serve as another reminder, if such were needed, of the dependence on exports of a vehicle output running above a million units a year.

On a booming home market with credit easier than at any time since the war over 691,000 out of the British car industry's total 1959 product of 189,970 cars and taxis and 353,105 goods vehicles, were sold abroad.

If Luton, Dagenham, the Midlands, and more distantly, Bathgate, Llanelly and North Staffordshire are to be kept at full stretch through visitations of five per centism, then even more export success will be needed—in the ever more competitive overseas markets.

After the American Steel Strike

The return to work of the steel workers and of the last of the 650,000 others thrown out of their jobs by the United States' steel strike has produced the unusual result of the number of unemployed in the States falling by 93,000 in December, a month when seasonal influences normally take the figures in the opposite direction.

The number employed in the USA has now risen to the record level of 65,699,000. Coming at a time when Mr. Khrushchev is loudly raising his work force by 1,200,000 men, and releasing all the industrial potential that was formerly tied up with supporting these soldiers and airmen, the signs of strength in the post-strike American economy are imposing.

But not so imposing as all that. A leading American democrat, Senator Humphreys, has thought it right to allege that President Eisenhower's last budget is legislating America "into a second class power." The Eisenhower administration has changed the whole prospect of the American aviation industry by its decision not to back mass production of the supersonic B 70 bomber but to call instead for two prototypes. Something like $1,000 million of work has been lost to the major air firms and their sub-contractors. What the American Government feels it cannot afford is not likely to be taken up even by a joint project of the two new British air groups.

Russian plans are not so publicly proclaimed but with Mr. Khrushchev's exuberant emphasis on rockets it may be that the aviation industry of the world has to undertake the development into Mach 2 and Mach 3 transport flying without fat service contracts to carry the losses.

On a more domestic level the United States Treasury survey of 1959 and prospects for 1960 is a long record of a nation of high level consumers with every confidence of lifting the level in 1960 to even greater motoring, home equipping, travelling and industrial purchasing.

Savings in the United States have been rising rapidly, though not so fast as in Britain, and at the same time the hire purchase debt soared to $52,200 million. All this adds up to an opportunity for British exports, and not only in consumer goods, to reach above the billion dollar export total of last year and to go on improving the position. Looking East the amount of factory buying and general capital investment purchasing Soviet trade delegations in the West will be negotiating is increasing as the USSR puts tools into the hands of its million new recruits.

Reinforced Plastic has Great Strength

Incorporation of continuous, non-woven glass filament in an epoxy resin has yielded a preimpregnated material which can be consistently moulded to give greater strength to weight ratios than the highest strength alloys.

Material	Tensile strength, 10^3 lb per sq. in	Modulus in tension, 10^6 lb per sq. in	Tensile strength/weight ratio	Specific gravity
Mild steel	60	30	1·0	7·8
Stainless steel, CW	185	29	3·1	7·8
Chrome steel, HT	260	30	4·3	7·8
Magnesium alloy	47	6·2	3·4	1·8
Aluminium alloy	88	10·4	4·2	2·7
Titanium alloy	152	16·9	4·5	4·4
Be-copper	170	19	2·6	8·4
Scotchply 1002: Unidirectional	110	5·5	7·9	1·8
Crossplied	68	3·7	4·9	1·8
Isotropic	57	2·6	4·1	1·8

The largest reinforced plastic cylinder ever made has been produced in America from a pre-impregnated material containing continuous filaments of glass. Scotchply reinforced plastic, as it is called by the makers Minnesota Mining and Manufacturing, was used because it has a strength to weight ratio greater than the highest strength steel or titanium alloys. Properties are indicated in the right-hand table.

What is holding up the exploitation of desirable properties of reinforced plastics? There are several reasons. Although plastics need no protection from most chemicals, there is little long term performance data in existence, and the validity of accelerated tests in only a matter of speculation and probably sufficient to deter conservative designers. Also, although good mechanical properties *can* be produced under the right conditions, the normal method of hand layup gives notedly unreproducible results. Then the modulus of elasticity at a typical 1×10^6 lb per sq. in is only one-thirtieth that of steel, and the cost of the materials can never conceivably become competitive with that of metals. Having unburdened that list of " why-nots," take a look at this new preimpregnated material, Scotchply.

Scotchply is still, by metal standards, expensive, but this is only the material cost. Great savings are incurred in fabrication of large, complex structures, for the moulding process demands a pressure of only 20-100 lb per sq. in and a temperature of 330° F for 5 min for curing. The preimpregnated material of the type 1002 considered here has a shelf life of 6 months at 70° F and is quite ready for use. Unreproducibility of mechanical properties is avoided. What is more, these reproducible properties include a modulus of $5{\cdot}5 \times 10^6$ lb per sq. in in the direction in which the glass filaments are laid, which is still half this value in the isotropic sheet.

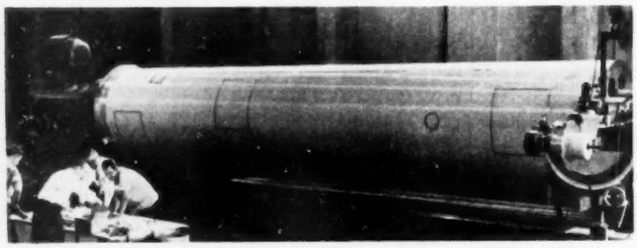
This reinforced plastic can be obtained through the British company at 3M House, Wigmore Street, London, W1.

The key to the good properties is that the glass filaments are continuous and are laid out linearly in one direction only. There is no crimping of the filaments to decrease the modulus, and the lack of sliding of one filament over the other, as in chopped strand mat, probably accounts for the high creep strength and good fatigue properties. Unidirectional Scotchply is made in a thickness of 0·010 in in any width from ¼ to 48 in. A grade called Crossply is made up of two of these with the filaments at right angles to one another. Yet a third is called Isotropic; with three plies at 60° to one another. The properties are shown in the polar diagrams.

From looking at these diagrams it can be seen that the transverse strength of the unidirectional material is very poor—about the 7,000 lb per sq. in mark. However, when " averaged out " in the isotropic sheet the overall strength is still over 50,000 lb per sq. in which offers the same strength to weight ratio as the best steel. In other words on top of a material which basically has a very high strength can be added layers of unidirectional material which can cope with directional stress peaks.

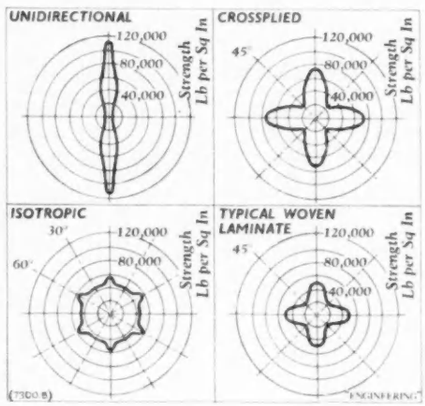
What has it been used for? One severe application is for the cheek plates in the centre of helicopter rotors made by Kaman Aircraft in the USA. Prewitt Aircraft have used it for construction of battery cases which are highly stressed during acceleration of missiles; then there is the missile cylinder shown above made by Zenith Plastics of California for Lockheed Missile and Space Division.

Even down on earth where the economics siren sounds louder, there are a number of well-established uses in America. Flat springs is one of these, another is the outside laminate for sandwich panels. Fatigue resistance is good, and lamination and water penetration present no problems compared with polyesters reinforced with random glass fibres. The spring outlet, in fact, is very promising.



(Left) Missile application exploits high strength to weight.

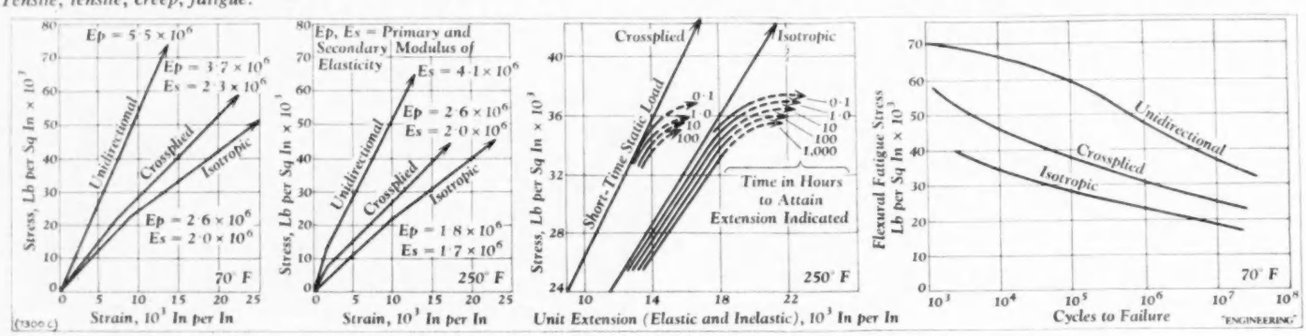
(Right) Directional properties of various grades of sheet.



The same combination of properties required for springs explain why it is popular for the highly stressed facing layers of archery bows. An even stronger laminate is made for this application which has a strength of 200,000 lb per sq. in.

In this country, interest is being taken in the material for a number of applications in addition to those already mentioned. As in the United States, the aircraft and missile industries—where strength to weight ratio is a prime consideration—are two of the biggest potential outlets. One of the most interesting possibilities in this connection is its use in compressor blades for gas turbine engines, development of which is at an advanced stage. The manufacture of slot wedges and printed circuitry are two of its many applications in the electrical industry.

Mechanical properties; from left to right: Tensile, tensile, creep, fatigue.



Phosphating, Degreasing in One Emulsion Bath

A British company is now marketing a petroleum based chemical which when added to established phosphating baths will satisfactorily degrease components before coating. It is called Waltersolv and is made by Walterisation Company. This may be compared with the product of Du Pont mentioned in a previous issue in which the same overall operation was performed by making an addition to a trichlorethylene vapour degreasing bath (ENGNG., 8 Jan. '60, p. 39).

Although no results have yet been made known as to the protective nature of the two phosphate films so produced, there are important differences in the process. The emulsion cleaning process needs no special tanks and is cheap to install and operate while the trichlorethylene process needs special equipment. However, the one great advantage of the latter method is that the solution is self cleaning, whereas any dirt or grease removed by the emulsion process is held in solution and builds up until the bath must be emptied for a fresh start. This difference is still true with the new additives.

Waltersolv consists of degreasing and emulsifying agents in solution in a high boiling point fraction derived from petroleum. This has a flash point of 120° C and a boiling point of 260 to 290° C. Although these temperatures are relatively high, there is a fire hazard with the material which is not present with trichloroethylene. The emulsion additive is used in quantities of 10 per cent bath capacity, preferably with the range of highly-accelerated zinc-phosphating solutions such as the Fasbond processes, Fasbond A being the most effective.

The heat requirements for emulsion baths are low, and in this respect the Waltersolv additive is helpful, because, in addition to forming an emulsion with the phosphating solution, part of it separates out to float on the surface where it acts as a heat barrier with low conductivity. Reductions in heat requirements of 75 per cent have been experienced.

Total degreasing and phosphating time is about 10 minutes and this must be followed by running cold and static hot-water rinses. Chemical consumption of the Fasbond chemicals is reduced, but the Waltersolv layer must be skimmed or siphoned off as it absorbs grease and dirt, and it requires topping up as it is dragged out with components.

Walterisation Company Limited, Purley Way, Croydon, Surrey.

Fuel Additive Prevents Fouling and Sludge

Troublesome sludge in fuel bunkers, fuel strainers, and heat exchangers, as well as burner fouling deposits on fuel injector tips, can be minimised and, in some cases, eliminated, with a Du Pont chemical that is simply added to the fuel oil on board ships.

Known as Marine Heavy Fuel Additive-1 (MHFA-1), the chemical, described as a methacrylate copolymer in a kerosine diluent, breaks up the sludge-forming components of fuel oils and disperses them evenly and finely through the fuel so they will pass easily through burner nozzles and be consumed with the fuel.

Where sludge already has built up in bunker bottoms, an addition of 4 to 6 pints of MHFA-1 to each 1,000 gallons of fuel oil, accompanied by agitation or recirculation, will usually break down the accumulated sludge and disperse it through the oil sufficiently to eliminate the need for costly bunker cleaning. Once the sludge has been dissolved, regular use of MHFA-1 at the rate of 1 to 2 pints per 1,000 gallons of fuel will prevent sludge formation and assure clean bunkers, strainers, and burner tips.

Covered with heat-robbing sludge, tubes in fuel oil preheater appeared as in the top illustration at the start of an additive test. Six months after MHFA-1 was incorporated in the fuel oil, the heater tubes were much cleaner, as is shown in the lower illustration. In addition, use of the additive resulted in a decrease in the amount of steam needed to heat the coil.

New fuel additive will disperse sludge of this nature.

In addition, the chemical is said to help to disperse "water bottoms" and reduce burner failure due to "water slugs." MHFA-1 is being offered by the Du Pont Petroleum Chemicals Division through agents in all important ports in the USA and abroad.

E.I. Du Pont de Nemours and Company, Wilmington 98, Delaware, USA.

New Neoprene Latex and Hypalon Rubber

While Du Pont are busy expanding their facilities and technical services in the United Kingdom and Europe, the company back in the United States is busy developing new materials. Two of the more recent ones include an improved neoprene latex and a grade of Hypalon which is easily processed.

The latex is neoprene 400 which, in addition to having greater heat resistance than previous latices, is said to have three times the tear strength and 15 times the ozone resistance. Both these properties and increased modulus are imparted to other types of neoprene when it is used in a blend. This colloidal suspension of elastomer in water is extremely stable and has good heat-aging properties. The solids content is 50 per cent.

Chemical resistance, which is the noted property of neoprene, is very good, but the new grade is not so resistant to aromatic compounds at high temperature. Du Pont envisage that it will be used for automotive and industrial dipped goods and also as a binder for natural and synthetic fibres since its adhesiveness is high and it does not discolour fibres or reduce their properties.

The Hypalon 40 also has improved properties all round and is preferable to other grades except for solution applications where its high viscosity is a disadvantage. Before vulcanising it readily accepts fillers and can be processed at low temperature. Calendering of a two-mil film, 60 in wide, was carried out with ease in one test: the film was removed by one man without distortion or tearing. Extrusions are very smooth and die swell is low. Tubing with a 2 in interior diameter has been extruded with $\frac{1}{8}$ in walls without collapse, shrinkage or weak spots. With these attractive properties, the material is expected to find its greatest use in wire jackets, hose tubes and covers, coated fabrics and extruded goods.

E.I. Du Pont de Nemours and Company, Wilmington 98, Delaware, USA.

Hose and Ducting Better with Polyester Fibres

Terylene, the British polyester fibre, is not only very strong, but it also has good resistance to water. In this respect it is superior to high-tenacity rayon which loses half its strength when wet, and is slightly superior to nylon which absorbs typically 2 to 3 per cent moisture.

During the Second World War, Goodyear developed a hose of 5 in bore with a square woven-cotton reinforcement, which could be used for abeam refuelling, the hose being supported by a jackstay slung between the two vessels. Difficulties were experienced during stormy weather, however, to which the only simple answer was to develop a hose which could withstand the strains of being dragged between two ships refuelling astern. To this end, Goodyear first developed a 6 in bore hose reinforced with rayon, but this still proved not

Terylene-reinforced hose withstands the high stresses imposed in astern refuelling.

entirely satisfactory, because, under high stresses, it elongated with loss of flow rates. The two latest designs are 6 in hoses with Terylene reinforcement and built-in light-alloy fittings.

Underground, Terylene has scored another success. Various materials have been used in British mines for ventilation ducting including pvc-coated jute, rayon and cotton fabrics. Recently, a bulk order for more than 30 miles of pvc-coated Terylene has been placed by the National Coal Board.

Made up by Robert Watson and Company from a specially woven 2½ oz per sq. yd twistless

Lightness is one feature of ventilation ducting reinforced with polyester fibres.

Terylene-base fabric produced by C. A. Newsholme and Company, the ducting is about three times lighter than that formerly used. Its use results in easier handling, greater efficiency and longer life. Furthermore, its very high rot resistance and retention of tear strength are marked advantages in damp conditions.

Goodyear Tyre and Rubber Company (G.B.) Limited, Bushbury, Wolverhampton.

Imperial Chemical Industries Limited, Millbank, London, SW1.

Plain Words

By Capricorn

If market research fails a little company no one takes any notice, but when it fails a celebrated maker of motor-cars we can all learn something to our advantage.

The Ford Motor Company decided in November that so far as its Edsel car was concerned, enough was enough. The Edsel was launched as an attempt to achieve bigger Ford sales in the medium-price car bracket. In fact, it proved a most expensive failure. Development of this car is said to have cost about £250 million, and a further £200 million was lost during the 2½ years it was in production.

Perhaps the most important reason for failure was a misreading of the signs of what was going to happen in the motor-car market. Back in 1948 Ford decided to have a number of new manufacturing divisions. This plan was interrupted first by the Korean War and then by the long period taken up in preparing the "Continental" range. Then, in April, 1955, Ford organised a Special Products Division to develop a new medium-priced car. At the same time it set up the separate Lincoln and Mercury Divisions. In the meantime the Ford Fairline was introduced to give the company a competitor with the lower medium priced makes. It therefore appeared to be good business for Ford to sponsor a new and separate line of medium priced cars.

By September, 1957, however, when the Edsel appeared, the market was already overfull with cars of this size. The demand now, in a recession period, was for small economy cars of the type which were only to be had from abroad. The Ford Fairline had pushed up standards for what had been the lowest priced range. So, with the customers wanting to pay less anyhow, and the low priced American range barely within their reach, the chances for any brand new medium priced car appearing at this time were obviously slight. And, of course, the Edsel was not just one car—it came out in four separate and differently priced models. This meant that it straddled not only the General Motors price range but also Ford's Mercury and Lincoln makes as well. A new dealer network had to be set up to market Edsel. And this was something that no American car maker had succeeded in doing since the 1920's.

Last year Ford had cut the Edsel range down to two models, both at the lower end of the medium price range. Mercury, Edsel and Lincoln dealers were combined and given British and German Ford cars to sell as well. But it was too late. The coming of the Ford compact car, the Comet, was the last straw. This also is being handled by Lincoln-Mercury dealers.

Does this mean that Ford will cut out market research? No, Sir. I think they will do it more thoroughly than ever. The market-research crystal ball is an expensive toy but wealthy boys can't do without it.

Letters to the Editor

Britain's Railways

SIR, I can only presume that the author of "Why the French Enjoy their Railways" (ENGNG., 15 Jan. '60, p. 83) must have been influenced by the excuse specialists of the British Transport Commission.

Surely an unbiased and clear-thinking engineer cannot be expected to believe the following extract referring to the Société Nationale des Chemins de Fer Français: "Its major advantage over British Railways lies in the near total destruction of its rolling stock during the war. This enabled a quick and effective transition to electric and diesel traction which now handle over half the total traffic. It also made possible a complete re-planning of the whole system, largely unhindered by either the existence of large quantities of half-written off but obsolete equipment or by too much tradition."

There must be many scrap dealers who would pay British Railways for the privilege of removing their disadvantage, while avoiding the other costly and unpleasant effects of war-time destruction.

The real advantage possessed by the SNCF is indicated in the second sentence of the article: "Yet it is a highly progressive and dynamic organisation, managed by men of outstanding ability and utilising the most modern techniques."

Will we ever be able to say the same of our railway services?

Yours faithfully,
ANDREW HARKESS.

30 Singleton Scarp,
London, N12.
16 January, 1960.

Company Taxes Aid Russia

SIR, I have not seen in print the simple reason why Russia must overtake the West in productivity in the near future, unless conditions are altered.

The reasons are that, in the West, company profits are taxed and in Russia they are not. This means that if, in Russia, a production engineer can guarantee the management a 5 per cent increase of efficiency for a certain capital expenditure, it is worth doing. In the West, however, no increase of under, say, 10 per cent, is, in practice, undertaken, because, if it comes off, the Inland Revenue will take half of it, and if it does not, it is too bad for the management.

I may say that, in quoting 10 per cent, I am being conservative and believe the true figure to be much higher.

Yours faithfully,
J. B. ALDRED,
Director.

Shirley Aldred and Company Limited,
Worksop.
22 January, 1960.

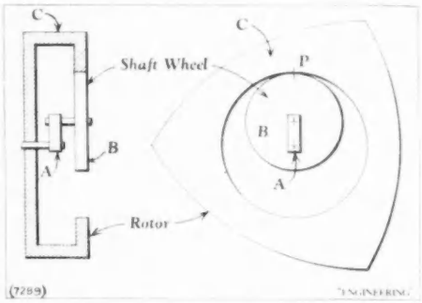
NSU-Wankel Engine

SIR, Having read with very great interest your articles on the new NSU-Wankel rotary piston engine (ENGNG., 4 Dec. '59, p. 580 and 25 Dec. '59, p. 676), and other articles in the press on the same subject, I set out to analyse the epitrochoidal shape of the casing and the gearing of the system.

With the aid of a scaled cardboard model I was able to illustrate the geometrical construction, but it very soon occurred to me that it would be possible for the rotor to turn through all its phases without causing any rotation of the driving shaft. I then investigated the mathematics of the problem and arrived conclusively at the same result; the data used being taken exactly from your second article. I have no wish to discredit in any way this most excellent invention, but knowing that several versions of this engine will have been designed and tested, I feel that possibly there has been some error in the release of certain information.

My scaled model of the rotor and the shaft wheel of the engine was made in stiff cardboard. The pitch circles of the two toothed wheels were chosen so that their diameters were in the ratio 2 : 3, as in the article (this is equivalent to 20 and 30 teeth). The epitrochoidal shape of the casing was obtained by rotating the components through the positions shown in the article but it was soon observed that to do this the rotor could maintain rolling contact with the shaft without the shaft itself actually turning at all. A mathematical investigation was then considered, and after some considerable thought the angular velocity of the shaft was proved to be zero by more than one method of calculation; also another conception was evolved for considering this problem. If the casing is replaced by a crank connecting the centres of the two toothed wheels, the problem can then be treated as one of only a simple epicyclic.

It can be seen from the accompanying sketch, or from the four diagrams in the article, that if



Schematic construction has been employed in the cross-section above, in order to make the crank (A) practicable.

the rotor completes one revolution, the point of mesh completes three; or, when the rotor has turned through 30°, the point of contact has moved round 90°. Suppose that the whole system be rotated entire through 360°, each of the components being fixed to the others and then fixing the crank in space, the rotor will be turned back through two-thirds of a revolution, the shaft wheel turning as the teeth dictate; the crank will have turned three times as much as the rotor, i.e., the point of mesh will have turned three times as fast as the rotor which is one of the conditions. (It can also be seen that P (the point of mesh) must lie in line with the two shafts always.) Let the crank be named A, the shaft wheel B and the rotor C, and let $1 - x$ be the rotation of B in revolutions; so tabulating:

	A	B	C	
360° entire	1	1	1	(revs.)
A fixed—C turned −240°	0	$-x$	$-\frac{2}{3}$	,,
Result	1	$1-x$	$\frac{1}{3}$	,,

Now if the ratio of the numbers of teeth is 3 : 2 as suggested in the articles:

$$-x = -\tfrac{2}{3} \times \tfrac{3}{2} \quad \text{i.e., } x = 1.$$

In other words, the shaft wheel, B, has no resultant velocity. $(1 - x = 0)$

And this is exactly the conclusion reached by my other calculations and that observed on the model. It was noticed, however, that the size of the wheels could be varied providing the difference in their diameters remained constant; thus, using the ratio 4 : 3:

$$x = \tfrac{5}{9} \quad \text{and} \quad 1 - x = \tfrac{1}{9}$$

i.e., the shaft would rotate at one-third of the speed of the rotor.

So generalising, we can say that if the ratio is less than 3 : 2 (for example, 4 : 3, 5 : 4, etc.),

there will be some positive rotation of the shaft, and if the ratio is greater, say 2 : 1, it will be negative. (In fact, for 2 : 1 $x = \frac{4}{3}$, so $1 - x = -\frac{1}{3}$.)

However, in the second article it is stated that the speed of the shaft is half as much again as that of the rotor, or rather that the rotor turns at two-thirds the speed of the shaft (which also agrees with the performance figures); and in order to get this the gears would have to be chosen so that $x = \frac{1}{3}$, but this would mean a ratio of 3 : 4 (not 4 : 3), and to do that the inner wheel would have to be larger than the outer; which all seems very odd.

It does occur to me that the speed ratio quoted may have referred to some earlier design; for example, the one where the casing also rotated.

Yours truly,
J. R. J. DYKE.

1 Portway Cottages,
North Stoke, Oxon.
14 January, 1960.

Welding Thick Plates

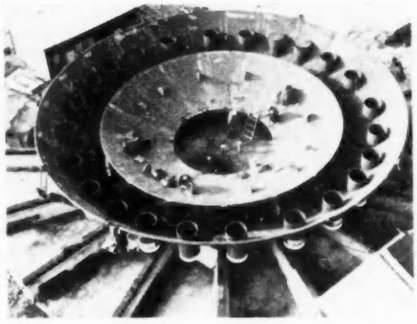
SIR, Mr. H. F. Ablitt's letter (ENGNG., 1 Jan. '60, p. 4) counters the statement made in the Atomic Review paragraph entitled "Welding Causes Delay at Chinon," that "the heaviest plate so far proposed for site welding by British Consortia is 3½ in at APC's Trawsfynydd."

Apart from the Bradwell nuclear power station where, as Mr. Ablitt states, more than a quarter of the shell plates are of 4 in thickness, mention has not been made of Latina nuclear power station. At this station, the whole of the pressure vessel has a thickness greater than 3½ in; one-third of the plate being 4⅛ in thick and the remainder 3⅞ in thick. Construction of this vessel started in May, 1959, and is about 50 per cent complete.

Two aspects are shown in the accompanying illustrations of the welding work being undertaken on the pressure vessel for Latina power station.

Yours faithfully,
W. C. HOLLIDAY,
Chief Welding Engineer.

Whessoe Limited, Darlington.
22 January, 1960.



Welding two elements of vessel bottom for Latina nuclear power station.

Grinding in progress on the welds of a reactor pressure vessel for Latina.

Car Designs for High Speeds

SIR, I was very interested to find that Mr. Gordon Wilkins, in his article "Designing Cars for the Motorways" (ENGNG., 22 Jan. '60, p. 116) drew attention to the fact that when many British cars are driven at high speeds their engine revs peak at a figure higher than most Continental designs. This reminded me that only a couple of days ago I saw a popular small British model halted in the nearside lane of the M1, its driver peering with a worried look at an expensive looking pool of oil which was slowly oozing across the road from beneath his crankcase.

One statement by Mr. Wilkins, however, cannot go without comment. "The availability of an excellent electrically controlled overdrive which permits full torque changes has solved this problem on the more expensive cars . . ." he writes. He is obviously referring to the original Laycock-de Normanville A type design for cars in the 2 to 3½ litre class. For some three years, however, the D type for 8 to 12 h.p. cars has been giving equally satisfactory service and is available as an optional extra, or as an accredited conversion fitment, on many popular models produced by, among others, such manufacturers as Ford, Sunbeam, Singer, Vauxhall, Standard, Hillman and Austin.

Yours faithfully,
G. W. KELLAND.

Laycock Engineering Limited,
Stratford House, London, W1.
22 January, 1960.

Stereophonic Reproduction

SIR, May I beg a little of your space to add a postscript to my article on audio frequency developments in the British Broadcasting Corporation (ENGNG., 15 Jan. '60, p. 100)?

Because of the inevitable delay between preparation and publication, increased in the present case by the after-effects of the printing dispute, it is not always possible in a survey of this kind to include reference to the most recent developments. Thus, my article, which was intended to cover a period of several years up to 1959, contained no reference to the subject of stereophonic reproduction, which has excited wide interest during the past year. I would not like to leave the impression, however, that the BBC's activities in stereophony are being confined to the present experimental two-channel transmissions on alternate Saturday mornings. In fact, consideration is being given to various schemes for broadcasting, by a single transmitter, stereophonic and monophonic versions of the same programme.

The engineering problems involved here are not confined to the radio-frequency field but extend to such audio-frequency matters as the effect of differing time delays on the land lines between studio and transmitter and the microphone arrangements required to preserve "compatibility" between the monophonic and stereophonic programmes. The subject is a highly complex one and is being studied in detail by various technical bodies in Europe and America. However, this is not the place for a dissertation and for further information I would refer readers to two papers presented by members of the BBC Research Department at the Convention on Stereophonic Sound Recording, Reproduction and Broadcasting held by the Institution of Electrical Engineers last March.

The papers referred to are "Survey of Stereophony," by T. Somerville; and "A Survey of Stereophony as Applied to Broadcasting," by D. E. L. Shorter, *Proceedings of the I.E.E.*, vol. 106, Part B, Supplement No. 14.

I also take this opportunity of making belated acknowledgments to Standard Telephones and Cables Limited, for providing the photographs in Figs. 2 and 3 of my article.

Yours faithfully,
D. E. L. SHORTER.

Research Department,
British Broadcasting Corporation,
Kingswood Warren, Tadworth.
22 January, 1960.

Events in Advance

Machine Tools at Olympia

An exhibition devoted solely to the display of machine tools was first staged in 1912 and the International Machine Tool Exhibition 1960 is the ninth event in the series then begun. It will take place at Olympia during the fortnight commencing 25 June. As has been the case throughout the whole series, this year's exhibition will provide opportunities for management and the technical side of industry in the engineering sector to view a concentration of up-to-date types of machinery and equipment, such as are required to solve their production and development problems. Exhibits on show will include products from abroad as well as those of United Kingdom origin.

The "international" aspect of the event is emphasised by the fact that the Machine Tool Trades Association, who organise these exhibitions, admit to membership both manufacturers and importers of machine tools, and every machine tool which is represented in this country by a member of the Association is eligible for showing at Olympia. Progress in the development of new machine tools is stressed by the Association's general exhibition regulations, which, at the instance of the members themselves, preclude the possibility of machine tools being displayed at other exhibitions in the United Kingdom, thereby relieving the manufacturers of having to consider taking part in a whole series of exhibitions.

Machine tools covering a very wide range of types and sizes, with some weighing more than 100 tons, will be on view at the coming exhibition. All the machines will be under power and, in many instances, will be engaged upon actual production runs. Heat-treatment and welding equipment, woodworking machinery, small tools, grinding wheels and many other types of ancillary equipment will be displayed on the quarter of a million square feet of exhibition space available. Naturally, there will also be a full range of control equipment, electronic and mechanical.

Exhibitions and Conferences

Fire Protection Conference, National.—Thurs., and Fri., 25 and 26 Feb., at the Connaught Rooms, Great Queen Street, London, WC2. Arranged, with the support of the Home Office and the Ministry of Labour and National Service, by the Fire Offices' Committee Fire Protection Association, 31-45 Gresham Street, London, EC2. Tel. MONarch 7412.

Leipzig Spring Fair.—Sun., 28 Feb., to Tues., 8 Mar., at Leipzig. Consumer goods and technical and capital equipment. Fair offices: Postschliessfach 329, Leipzig C1, Germany. Agents: Leipzig Fair Agency, 39 St. James's Place, London, SW1. Tel. HYDe Park 3111.

Utrecht International Trade Fair.—*Consumer Goods:* Mon., 29 Feb., to Sat., 5 Mar., at Utrecht. *Technical Fair:* Tues., 5 April, to Thurs., 14 April, at Utrecht. Agent for the UK: Mr. W. Friedhoff, Netherlands Chamber of Commerce, 10 Gloucester Place, London, W1. Tel. WELbeck 9971.

Ideal Home Exhibition.—Tues., 1 Mar., to Sat., 26 Mar., at Olympia, London, W14. Organised by Associated Newspapers Ltd., 161-163 Queen Victoria Street, London, EC4. Tel. FLEet Street 6000.

Electrical Engineers Exhibition, Ninth.—Tues., 5 April, to Sat., 9 April, at Earl's Court, London, SW5. Sponsored by the Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (Tel. LANgham 5927); and organised by Electrical Engineers (ASEE) Exhibition Ltd., 6 Museum House, 25 Museum Street, London, WC1. Tel. MUSeum 3450.

Mineral Processing Exhibition.—Wed., 6 April, to Sat., 9 April, at Church House, Great Smith Street, London, SW1. Sponsored by the British Chemical Plant Manufacturers Association, 14 Suffolk Street, London, SW1 (Tel. WHItehall 0766); and the Institution of Mining and Metallurgy, 44 Portland Place, London, W1 (Tel. LANgham 3802). Organised by Industrial Exhibitions (Services) Ltd., 9 Argyll Street, London, W1. Tel. GERrard 1622.

Swiss Industries Fair.—Sat., 23 April, to Wed., 27 April, at Basle. Apply to the Commercial Attaché, Swiss Embassy, 18 Montagu Place, Bryanston Square, London, W1. Tel. PADdington 0701.

Hardware Trades Fair, International.—Mon., 9 May, to Fri., 13 May, at Olympia, London, W14. Organised by Universal Exhibitions Ltd., 74 Holland Park, London, W11. Tel. PARk 7360.

Office Management, International Conference.—Mon., 23 May, to Thurs., 26 May, at the Show Mart, Montreal, Canada. Organised by the National Office Management Association. Apply to the Field Service Division, NOMA, 1927 Old York Road, Willow Grove, Penn., USA.

Iron and Steel Institute, Special Meeting in Italy.—Sun., 29 May, to Sat., 11 June, at Genoa, Milan, Rome, Turin and other centres. Organised at the invitation of the Associazione Italiana di Metallurgia. Offices of the Institute: 4 Grosvenor Gardens, London, SW1. Tel. SLOane 0061.

British Electrical Power Convention.—Mon., 30 May, to Thurs., 2 June, at Bournemouth. Offices of the Convention: Eastcastle Street, London, W1. Tel. MUSeum 4040.

Liége International Fair.—Thurs., 2 June, to Thurs., 16 June, at Liége, Belgium. Agent: Mr. R. C. Liebman, 178 Fleet Street, London, EC4. Tel. CITy 5889.

World Power Conference, Sectional Meeting.—Sun., 5 June, to Thurs., 9 June, at Madrid. Theme: "Methods for Solving Power Shortage Problems." Apply to the secretary, British National Committee, World Power Conference, 201-202 Grand Buildings, Trafalgar Square, London, WC2. Tel. WHItehall 3966. *Note:* The Sixth Plenary Meeting of the Conference will take place in Australia in 1962; and there will be a Sectional Meeting in Switzerland in 1964.

British Exhibition and Trade Fair.—Fri., 10 June, to Sun., 26 June, at the Coliseum Exhibition Building, New York. Organised by British Overseas Fairs Ltd., 21 Tothill Street, London, SW1. Tel. WHItehall 6711.

St. Erik's Fair, 18th International.—Wed., 31 Aug., to Sun., 11 Sept., in Stockholm. Fair offices: 16-18 Lidingövägen, Stockholm 28, Sweden. Agents: Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

European Fair, Strasbourg, 35th.—Sat., 3 Sept., to Sun., 18 Sept., at Strasbourg. Fair offices: 9 Rue Brulee, Strasbourg.

Brewers' Exhibition.—Mon., 3 Oct., to Fri., 7 Oct., at Olympia, London, W14. Organised by Trades Markets and Exhibitions Ltd., 623 Grand Buildings, Trafalgar Square, London, WC2. Tel. WHItehall 1371.

Machine Tool Trades Exhibition, Intenational—Sat., 25 June, to Fri., 8 July, in London. Organised by the Machine Tool Trades Association, Brettenham House Lancaster Place, London, WC2. TEMple Bar 3606.

Meetings and Papers

British Institution of Radio Engineers

LIVERPOOL
"Distribution of Sound and Television by Wire," by A. W. Mews. Merseyside Section. University Club, Liverpool. Tues., 2 Feb., 7 p.m.

MANCHESTER
"Acoustics in Modern Buildings," by E. S. Benson. North Western Section. College of Technology, Sackville Street, Manchester. Thurs., 4 Feb., 6.30 p.m.

British Interplanetary Society

LONDON
"Use of Reinforced Plastics in Rockets," by A. Wilson. Caxton Hall, off Victoria Street, SW1. Tues., 2 Feb., 7 p.m.

Chemical Society

HULL
"Atomic Reactions," by Dr. J. W. Linnett. Hull Branch. Chemistry Department, The University, Hull. Thurs., 4 Feb., 5 p.m.

Helicopter Association

LONDON
"Helicopter Operations of New York Airways," by R. L. Cummings, Jnr. Royal Aeronautical Society, 4 Hamilton Place, W1. Fri., 5 Feb., 6 p.m.

Illuminating Engineering Society

EDINBURGH
"Lighting and Safety in Building Operations and Works of Engineering Construction," by J. Gordon Scott. Edinburgh Centre. YMCA, 14 South St. Andrew Street, Edinburgh. Wed., 3 Feb., 6.15 p.m.

Institute of Fuel

LIVERPOOL
"Water Treatment, by C. J. Carter. Merseyside Subsection. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Thurs., 4 Feb., 7 p.m.

Institute of Marine Engineers

CARDIFF
"Safety at Sea," by S. Hogg. South Wales Section. Welsh College of Advanced Technology, Cathays Park, Cardiff. Mon., 1 Feb., 6.45 p.m.

LIVERPOOL
"Centrifugal Purification of Oils for Marine Service," by M. E. O'Keeffe Trowbridge. Annual General Meeting. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Mon., 1 Feb., 6 p.m.

Institute of Petroleum

LONDON
"Regional Trends in Crude Oil Gravities in the Middle East," by Y. P. Wilson. Wed., 3 Feb., 5.30 p.m.* (Meeting cancelled.)

Institute of Refrigeration

LONDON
"Polyurethane Foams: Their Contribution to Heat Insulation," by J. M. Buist and R. Hurd. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 4 Feb., 5.30 p.m.*

Institute of Sheet Metal Engineering

MANCHESTER
"Uses of Plastic-Coated Sheet Steel," by R. G. Timms. North Western Branch. Engineers' Club, Albert Square, Manchester. Wed., 3 Feb., 7 p.m.

Institution of British Agricultural Engineers

BIRMINGHAM
"Standardisation of Farm Machinery." Discussion. West Midlands Centre. Gosta Green Technical College, Birmingham. Mon., 1 Feb., 7.30 p.m.

Institution of Chemical Engineers

BIRMINGHAM
"Exchange of Deuterium Between Hydrogen and Liquid Ammonia," by P. J. Bourke and J. C. Lee. Midlands Branch. Midland Hotel, Birmingham. Wed., 3 Feb., 6.30 p.m.

Institution of Civil Engineers of Ireland

DUBLIN
"Clady Hydroelectric Scheme," by G. Mahony. Mon., 1 Feb., 6.15 p.m.*

Institution of Electrical Engineers

LONDON
"Development of the Formulae of Electromagnetism in the MKS System," by Dr. P. Vigoureux. Measurement and Control Section. Tues., 2 Feb., 5.30 p.m.*
"The Shielding of Overhead Lines Against Lightning," by Dr. J. H. Gridley. Thurs., 4 Feb., 5.30 p.m.*
"Computers in Medical Use." Discussion opened by Dr. R. A. Buckingham and Dr. J. M. Tanner. Medical Electronics Discussion Group. Fri., 5 Feb., 6 p.m.*

LEEDS
"Turbo-Generator Performance under Exceptional Operating Conditions," by T. H. Mason, Dr. P. D. Aylett and F. H. Birch. North Midland Centre. Leeds and County Conservative Club, South Parade, Leeds 1. Tues., 2 Feb., 6.30 p.m.*

MANCHESTER
"Digital Computer Developments at Manchester University," by Dr. T. Kilburn. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 2 Feb., 6.15 p.m.

NEWCASTLE UPON TYNE
"An Outline of Television Studio Lighting Problems," by R. W. Koplick. North Eastern Centre. Conservative Club, Newcastle upon Tyne. Wed., 3 Feb., 7 p.m.

Institution of Engineering Designers

BIRMINGHAM
"Hydraulics." Discussion. Midlands Branch. Queen's Hotel, Birmingham. Wed., 3 Feb., 7 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Radio Astronomy and the Structure of the Universe," by Professor A. C. B. Lovell. Hugh Macmillan Memorial Lecture. Tues., 2 Feb., 6.30 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Mechanical Services in the New Lloyd's Building," by J. R. Kell. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 4 Feb., 6 p.m.

Institution of Highway Engineers

LONDON
"Some Modern Developments in Highway Bridge Design," by C. S. Chettoe. 11 Upper Belgrave Street, SW1. Fri., 5 Feb., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Engine Governors." Internal Combustion Engine Group Discussion. Tues., 2 Feb., 6 p.m.*
"Development of Some Unconventional Centrifugal Pumps," by U. Barske. Meeting in conjunction with the Hydraulics Group. Wed., 3 Feb., 6 p.m.*

GLASGOW
"Importance of Biomechanics as a Service to Man," by J. M. Zarck. Scottish Branch. Royal College of Science and Technology, Glasgow. Thurs., 4 Feb., 7.30 p.m.

NEWCASTLE UPON TYNE
"Jodrell Bank Radio Telescope," by C. N. Kingston. North Eastern Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 1 Feb., 6 p.m.

READING
"Gear Cutting," "Gear Grinding" and "Gear Shaving." Three papers by A. Sykes, to be read by H. R. Stansfield. Southern Branch. Technical College, Reading. Thurs., 4 Feb., 7.30 p.m.

Institution of Plant Engineers

LONDON
"Potentialities of Nuclear Power," by P. T. Fletcher. Royal Society of Arts, John Adam Street, Adelphi, WC2. Tues., 2 Feb., 7 p.m.*

EDINBURGH
"Leith Fertiliser Works," by G. B. White. Edinburgh Branch. 25 Charlotte Square, Edinburgh. Tues., 2 Feb., 7 p.m.

Institution of Production Engineers

DUNDEE
"Tool Design of Thermo Setting and Thermo Plastic Moulding," by A. G. Elwell. Dundee Section. Royal Hotel, Union Street, Dundee. Wed., 3 Feb., 7.30 p.m.

Institution of the Rubber Industry

CARDIFF
"Bonding Systems," by W. A. Gurney. South Wales and Monmouthshire Section. Royal Hotel, Cardiff. Mon., 1 Feb., 7.30 p.m.

SOUTHAMPTON
"Plastics and Rubber under Extreme Operating Conditions," by E. W. Russell. Southern Section. The University, Southampton. Thurs., 4 Feb., 7.30 p.m.

Institution of Structural Engineers

BELFAST
"Aircraft Structures," by R. Boorman. Northern Ireland Branch. Queen's University, Belfast. Tues., 2 Feb., 6.30 p.m.

NEWCASTLE UPON TYNE
"Housing the Dounreay Fast Reactor," by N. T. Barrett. Northern Counties Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 3 Feb., 6.30 p.m.

Junior Institution of Engineers

LONDON
Technical Film Display. Fri., 5 Feb., 7 p.m.*

Newcomen Society

LONDON
"Boat Store, Sheerness, 1859-60," by Professor A. W. Skempton. Wed., 3 Feb., 5.30 p.m.

Reinforced Concrete Association

LIVERPOOL
"The Joint Problem in Precast Reinforced Concrete Structures," by J. A. Derrington. 9 The Temple, 24 Dale Street, Liverpool. Wed., 3 Feb., 6.30 p.m.*

Royal Aeronautical Society

LONDON
"Suppression of Shock-Induced Separations by Boundary Layer Control," by H. H. Pearcey. Tues., 2 Feb., 7 p.m.

Royal Society of Arts

LONDON
"Modern Dyes," by Clifford Paine. Wed., 3 Feb., 2.30 p.m.

Society of Chemical Industry

MANCHESTER
"Future of Chemicals from Petroleum," by L. H. Williams. The University, Oxford Road, Manchester. Fri., 5 Feb., 6.30 p.m.

Society of Engineers

LONDON
Presidential Address, by E. G. Massy Collier. Geological Society, Burlington House, Piccadilly, W1. Mon., 1 Feb., 5.30 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
British Interplanetary Society, 12 Bessborough Gardens, London, SW1. (TATe Gallery 9371)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Helicopter Association of Great Britain, 4 The Sanctuary, London, SW1. (ABBey 5160)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Petroleum, 61 New Cavendish Street, London, W1. (LANgham 3583)
Institute of Refrigeration, New Bridge Street House, New Bridge Street, London, EC4. (CENtral 4694)
Institute of Sheet Metal Engineering, John Adam House, John Adam Street, Adelphi, London, WC2. (TRAfalgar 6171)
Institution of British Agricultural Engineers, 6 Queen Square, London, WC1. (TERminus 0140)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers of Ireland, 35 Dawson Street, Dublin.
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8. (BAYswater 9101)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Newcomen Society, Science Museum, Exhibition Road, London, SW7. (KENsington 1793)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgravia 3681)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244)

Road Plans by Air Survey and Computer

Aerial surveying combined with an electronic computer provides the engineer with a powerful tool that takes the drudgery out of road planning. The technique can also be applied to other types of civil engineering.

Air photography and photogrammetry are being linked with electronic computing to provide a powerful tool for the design of motorways, railways and other civil engineering works where an accurate assessment of earthworks is important. The principal exponents of this practice in the United Kingdom are Hunting Surveys Limited, who are developing an approach which they call "Hi-Spec." They are working in close conjunction with Elliott Brothers (London) Limited, who evolved the computer programme that is used and the computer on which the work is being done is the new National-Elliott 802. Cooperation between the two firms is convenient to arrange as both the appropriate divisions of Hunting and Elliott are located close together at Boreham Wood, Hertfordshire.

Air photography has for many years proved a valuable aid in the preliminary location of routes, particularly in the under-developed countries where the ground was difficult to survey directly or where the distances were excessive. In recent years the practice has been widely adopted in the British Isles, even though this country is possibly the best mapped area in the world; now, in relation to its size, it is probably more closely covered by aerial surveys than any other territory. Hitherto, to some extent, the preparation of the survey and the subsequent planning have been two independent activities. The new approach goes a long way towards integrating these two parts of the work.

The first and immediate advantage of aerial surveying is that it provides a broad picture of the site, showing the topography and structural features of the area more graphically than can be done with traced plans of a ground survey. Moreover, the information can be obtained without any direct entry having been made into the properties concerned. A second advantage is that a permanent record is obtained that can be constantly referred to without return to the site to obtain additional information. The most severe limitation likely to be met is a number of high structures or buildings in close proximity so that it is difficult to take a direct photograph of the ground line.

The first stage in aerial survey is to photograph the area using a high-precision camera that takes a picture size of 9 in by 9 in. To do this the aircraft flies over the ground and exposures are taken so that there is a 60 per cent overlap between adjacent pictures. Though it is desirable that the plane shall fly on as even a course as possible, the standard plotting equipment available is designed to eliminate discrepancies due to irregular movements of the aircraft. For the large scale plans that are required in this country it is normal for the aircraft to fly at 1,500 ft above mean ground level; this gives a photographic scale of 1/3,000 and a band width of usable photograph of 1 mile.

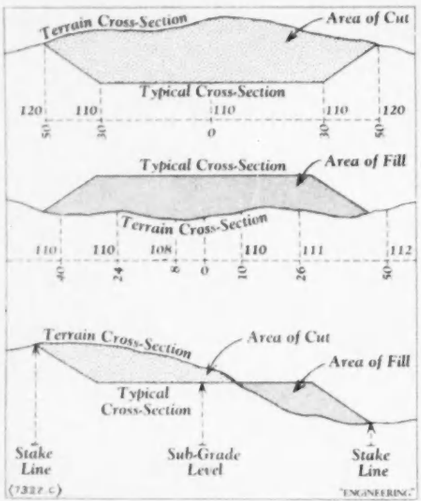
A mosaic is then built up of the area. A rough map can be obtained by "hand matching" the photographs but for all design purposes the mosaic has to be rectified to fit to ground control points that have been fixed independently. Successive photographs, or slides made from them, are mounted in the plotting machine which can be adjusted so that the slides occupy the same relative position and orientation as they did when the pictures were taken. This is done by a process of mainly trial and error in which the projected images of the two slides are made to give overlapping pictures that are stereographically consistent. According to the equipment the required outlines are then re-photographed, traced or reproduced by pantograph to make the finished plan. Changes in level can be deduced by the same principals: the images are thrown on to a table that is adjustable in height; when the height is correct there is no separation of the two images at the point in question and the level above a datum can be deduced.

Until recently it was customary to use these techniques to plot contours on to the maps. It became apparent however that subsequently the engineer had to interpolate between the contours to obtain the profiles and cross-sections that were most useful to him. Earlier practice has therefore been modified and it is now more usual to trace or plot the cross-sections directly. The accuracy of levels obtained directly from the aerial survey is $\pm$ 3 in and for much of civil engineering this is adequate for planning purposes. Where more accurate levels are required—for road intersections or drainage—ground surveying must be resorted to, but spot levels need only be taken at critical points.

Cross-sections are normally taken off at 100 ft intervals along the proposed route. The number of height values plotted depends on the nature of the ground, but of course special care is taken to pick up points where there is a change in level or gradient. The extent of the section plotted depends on the nature of the works and is made to cover the possible width that will be affected plus some allowance for small changes in alignment of the road.

Of prime importance to the cost of the proposed works will be the volumes of excavation and fill that will be necessitated by the chosen route. This is where the computer has been introduced. The data for the cross-sections and profile can be extracted in a form that is directly useful and capable of being fed into the computer; this usually takes the form of three coordinates, x and y in the plane of the ground and z the elevation. Also put into the machine, as part of the programme, are the characteristics of typical or designed cross-sections of the road and data that will define the location of the road

Two aerial photographs showing how realistically detail is obtained, in a way quite impossible with conventional ground surveying. The implications of new works would be more fully appreciated, especially by lay committees, if traced on maps built up from such photographs.



Typical (or designed) cross-sections imposed on terrain cross-sections. In "Hi-Spec" the computer effects this and computes the areas (and volumes) of cut and fill and the location of the stake lines.

in terms of alignment and level. Such is the discriminating powers of the computer that it will select the typical cross-section that will pertain at the section being considered, compare it with the terrain cross-section and abstract the areas of fill or cut that are required and also determine the stake lines, i.e. the extent of the works as defined by the intersection of the proposed slopes of embankments (or cuttings) and the existing terrain cross-sections. Built into the programme can be such criteria as limiting heights of embankment so that the machine will reject any absurd arrangements. From that point it is but a short step to programme the computer to evaluate volumes of cut or fill and to give running values along the route. The resulting figures are pointed out and presented in a convenient table.

The order of work to establish a new road line by Hi-Spec is therefore as follows. Using an aerial survey a photographic map of the stretch of country concerned is made to a scale of 1/2,500 and contoured at wide intervals. This provides the basis on which the preliminary line can be selected. The scale of the map is stepped up (without more aerial surveying) to 1/500 along the line and terrain cross-sections produced. The line is then adjusted and the typical sections designed. The material is fed into the computer and further adjustments made as may be found necessary.

The introduction of a computer brings the advantage that a small change of alignment can be examined to see if an improvement is obtained, with no increase in the amount of arithmetic to be handled manually. The Elliott 802 which is being used with Hi-Spec is able to handle 27 master cross-sections and will produce the results listed above at the rate of 1 mile in 12½ minutes.

It has been said that the high speed of the technique is of no value, since other aspects of road promotion—the conveyance of property, and so on—necessarily takes time in which the old methods of computation can be used. This criticism overlooks, however, the needs of the future, when the whole process of road design will have to be speeded up. On the basis of existing staff and equipment a 20 mile route can be surveyed and process outlined above completed in three or four months. The period is dependent upon good flying weather with a cloud base that is sufficiently high. The best periods for aerial surveying are likely to be spring or autumn; in winter the weather may not be kind and in summer vegetation can mask ground lines and give a false indication of ground levels.

Shell Structure Techniques

The newly formed International Association for Shell Structures (IASS) plans to hold a colloquium on "Precast Shells" during next autumn. Warsaw or Dresden are likely to be the centre chosen for the meeting. A meeting is also scheduled for September 1961, in Delft, when "Experimental Research on Shell Structures" will be discussed. This will be followed immediately by a third meeting, to be held in Brussels, to consider "Approximate Methods of Calculation."

The association has its headquarters in Spain. It is concerned not only with reinforced concrete shells, but with all materials, such as reinforced ceramics, metals, timber and plastics, that can be used to form a continuous surface, and also with structures that are comprised of triangulations of cables to form hanging shells. The president of the association is Professor E. Torroja; British members of the council are Professor A. L. L. Baker and Mr. R. S. Jenkins. The offices of the secretariat are at Alfonso XII, 3, Madrid 7, from where further details of membership and meetings can be obtained.

European Course in Sanitary Engineering

A European course in sanitary engineering is being organised by the Technological University at Delft and the Netherlands Universities Foundation for International Co-operation (NUFFIC) with the assistance of the Organisation for European Economic Co-operation (Paris) and the World Health Organisation (Copenhagen). The course will be held from 19 October 1960 to 14 September 1961.

The aim of the course is to provide civil engineers with special training to enable them to tackle water pollution in the densely populated and highly industrialised areas. Instruction will be based on a broad foundation of fundamental subjects like social backgrounds, hygiene, chemistry, microbiology and hydrology, and lectures will be followed by discussions of modern groundwater recovery and water supply, storage and purification of sewage, and the disposal and disinfection of solid wastes. As these subjects cover a wide field, participants will be able to specialise further when choosing subjects for the design exercises which deal with the details of either water supply or disposal of liquid and solid wastes.

The course will be of 11 months' duration with instruction in the English language. A number of excursions to interesting sanitary works in Western Europe are being arranged. At the end of the course diplomas will be awarded to those participants who have satisfied the Faculty Committee.

The tuition fee for the course is 2,000 Dutch guilders (£190). Further particulars are to be found in the prospectus which will be sent upon application to NUFFIC, 27 Molenstraat, The Hague, The Netherlands. Closing date for applications: 31 July, 1960.

Painting Asbestos Cement

The choice of paint to be used on asbestos cement products depends on a number of factors: the finished appearance desired; type and severity or exposure hazards; access for back painting; cost of initial application; and materials. A discussion of the problems and recommendations of paints suited for different uses are contained in a 12 page illustrated booklet available on request from Turners Asbestos Cement Company Limited, of Trafford Park, Manchester 17.

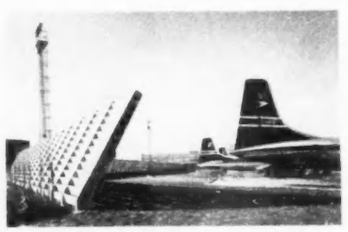
Most asbestos cements (all except those that are well weathered) exhibit a strong alkali reaction and best results are obtained by using alkali-resistant paints. Careful drying on both faces is necessary if blistering of the paint is to be avoided. Use of a primer is also recommended so as to obtain a uniform suction over the whole surface to the paint film.

Generally the oil-bound water paints, alkyd emulsions, and high gloss paints are not well suited for asbestos cement. Best are the cement and silicate paints, lime washes, casein-bound distempers and polyvinyl acetate paints. If impermeability is particularly required then chlorinated rubber-based paints and bituminous paints are recommended.

Blast Screen for Jet Airliners

A 1,000 ft long precast concrete blast screen has recently been completed at London Airport by the Modular Concrete Company of Bedfont, Middlesex. This was the second blast screen contract awarded to the company.

As may be seen from the photograph, the screen has dog leg frames, set at centres of 6 ft 4 in and bolted down to a continuous concrete footing of 30 in square section which is buried in the ground. The frames are 7½ in wide and have slots cast on both sides to hold the precast concrete planks which are 12 in wide by 1¾ in thick. The finished height of the screen is 12 ft 6 in.



Blast screens at London Airport.

Experimental work on the screens was begun in 1957 by the company working in cooperation with the engineering staff of the British Overseas Airways Corporation.

Tattersall's New Stand at Ascot

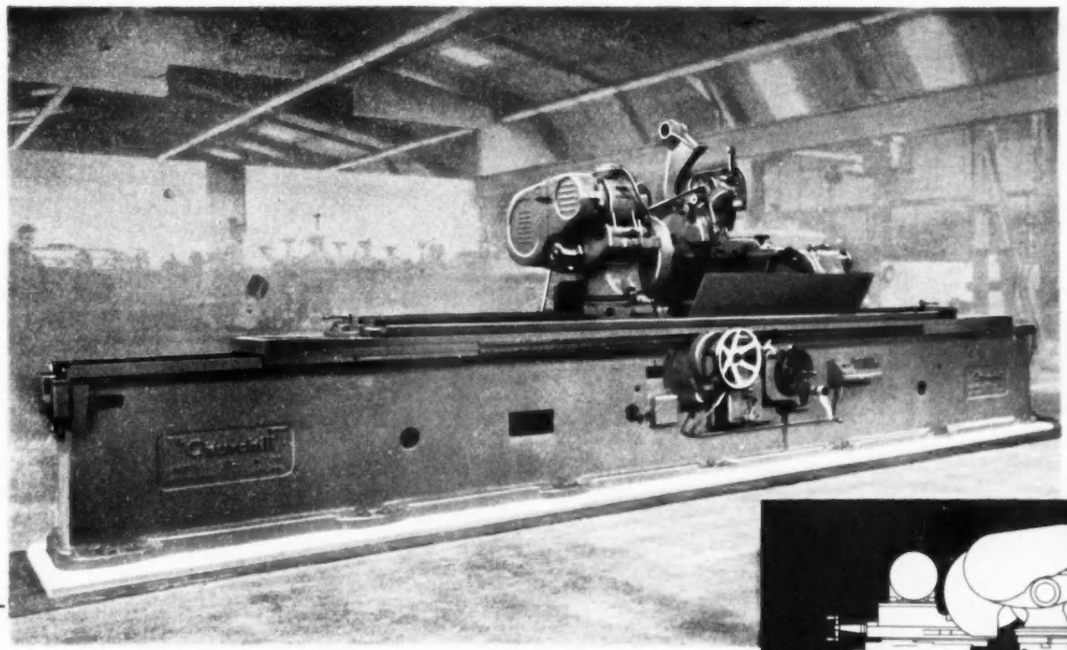
The new Tattersall stand at the Ascot racecourse is to be rebuilt by George Wimpey and Company at a cost of £1 million. The dismantling of the existing stand and rebuilding on the same site will be done between the July meeting of 1960 and Royal Ascot in June 1961.

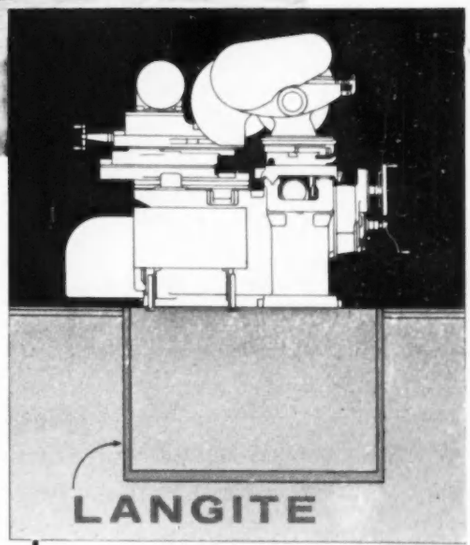
The new structure will provide 280 private boxes, each with its own dining room. Construction is on the split-level principle, so that the dining room for one box will be up a half flight and for the adjacent box half a flight down. Access to the boxes will be by lifts and escalators. Below the boxes will be private seating for 1,800 on the mezzanine and, in front of that, standing room for 8,000.

The main structure is of universal steel sections encased in concrete to give protection against corrosion. All shop joints are welded and site connections will be by high tensile bolts. The big flying canopy will be of lattice girder construction, heavily galvanised to minimise maintenance. All the flooring and infilling on the face of the stand will be of precast concrete. For the fascias of the balconies the concrete is being heavily ribbed. The site is on the Bagshot Sands so the foundations presented no problem.

The sub-contractor for the steelwork is the South Durham Steel and Iron Company who will fabricate the members at their works at Poplar. The steelwork will then be taken by barge up the river Thames to Windsor for the short road journey to the site.

Isolating vibration with LANGITE





The vibration problems brought to us vary a good deal: often it is necessary to provide a resilient mounting to a machine so that its shocks or vibrations are not dispersed to cause annoyance of personnel or interference with other machines.

This Churchill Universal Grinding machine is installed at Shell Refining Co. Ltd., Shell Haven, and comes in another category. The object here is to protect the grinder from vibrations arising from other machines in the plant, so that its accuracy may be unimpaired.

The grinder is carefully levelled and set upon a massive reinforced concrete block, which in turn is cushioned underneath and at the sides on pads of resilient Langite 4V.

The result obtained by these simple means is wholly satisfactory.

IMPORTANT USERS

Langite anti-vibration pads are also supplied to:
Ministry of Supply, Ministry of Works,
Air Ministry, Post Office,
British Railways, London Transport,
Central Electricity Generating Board,
British Broadcasting Corporation,
London County Council,
National Coal Board,
U.K. Atomic Energy Authority, etc.

ANTI-VIBRATION PADS OF

LANGITE

CORK MANUFACTURING COMPANY LIMITED, SOUTH CHINGFORD, LONDON, E.4

Telephone: **Silverthorn (*10 lines*)** ***Telegrams:*** **Uselangite, Easphone, London**

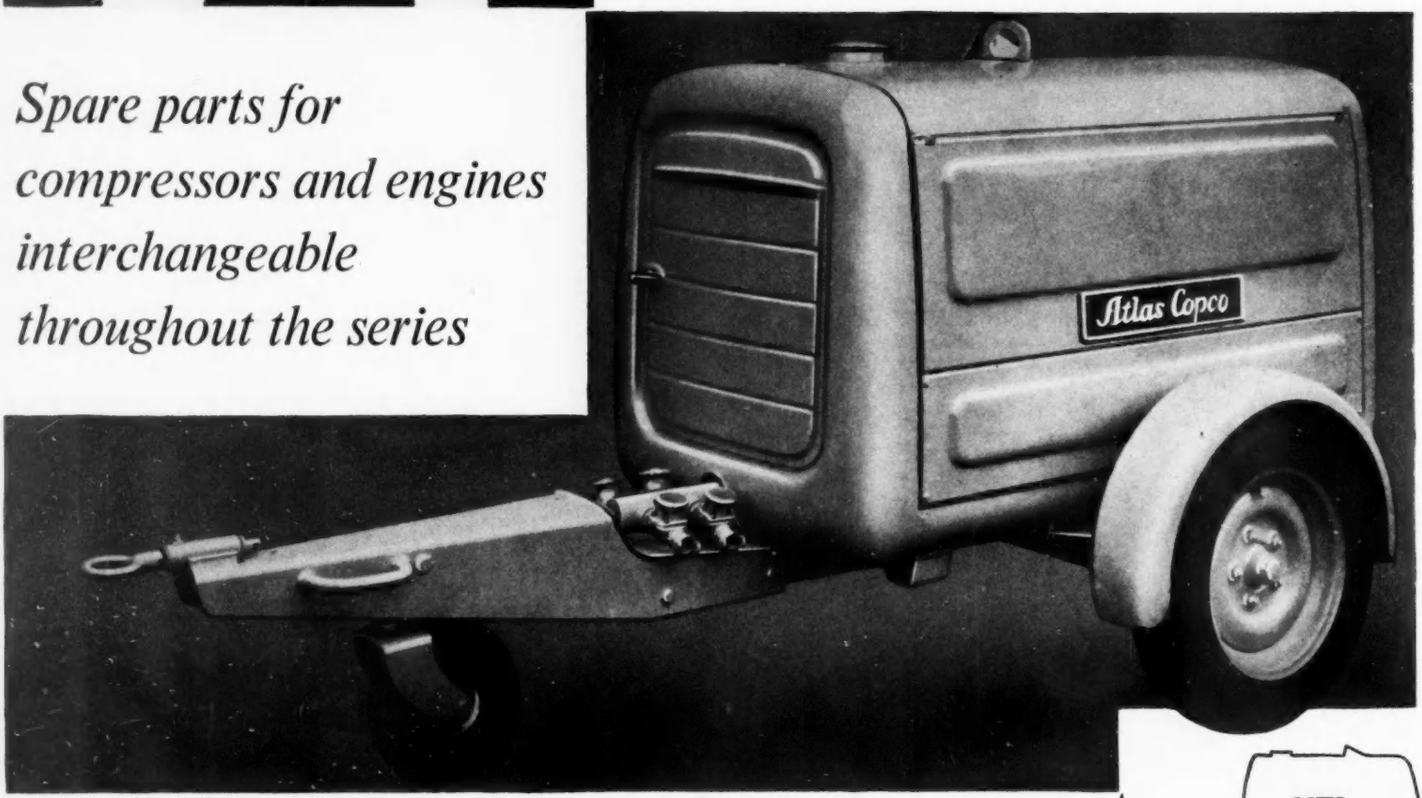
E3

VT

'PACKAGED POWER'

the world's lightest and smallest series of portable compressors—piston or rotary!

Spare parts for compressors and engines interchangeable throughout the series

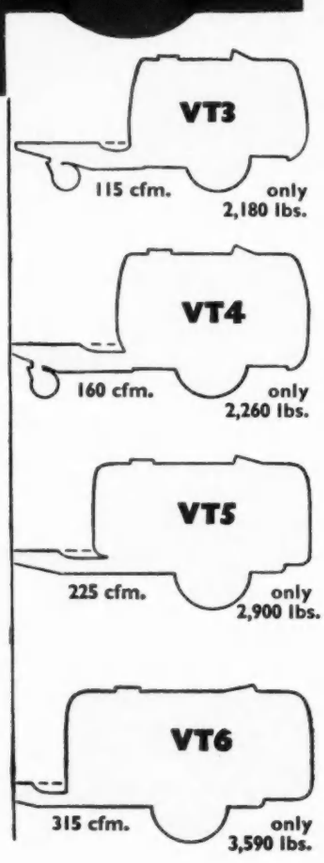


Atlas Copco now introduces a range of VT compressors, all incorporating the major changes in design and production that made the VT4 so successful. The VT series comprises four compressors with capacities from 115 to 315 cfm. These new machines have taken power/weight ratios into a new dimension, being lighter and more compact than any other type of compressor, piston or rotary, in their class.

- All machines can be supplied with either air or water cooled engines.
- The VT machines are the result of major changes in design and production methods. They are the only compressors with the crankcase, bellhousing and cylinder ducting in one piece welded design.
- Basic simplicity eliminates maintenance problems —local mechanics anywhere can service these units; the canopy is completely stripped in minutes; loosen three bolts and the complete engine-compressor unit lifts out; unscrew one nut and all four valves in the low pressure cylinder can be removed.
- The FUELMISER automatic speed adjuster means smooth running and fuel saving of up to 25%.
- Manhandling on site is a simple operation due to the low weight and pivoting nose wheel.

Torsion bar suspension and built-in lifting eye simplify transport problems.

- Powered by rugged air or water cooled engines, backed by world-wide service organisations.
- Both compressors and engines use the same type of lubricant.
- Fully automatic drain cocks simplify daily operation.



Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local Atlas Copco company or agent or write to: Atlas Copco AB, Stockholm 1, Sweden

Human Element

Goodbye to Tea Breaks?

Tea break jokes look like becoming of historical interest only as the movement towards shorter hours broadens.

The most recent announcement from an individual firm, Massey-Ferguson Limited, of a reduction to a 40-hour working week includes the ending of tea break time-out. Instead there is to be "a tea service without interruption to production." Time allocated in normal hours for washing is also being eliminated in most cases, which may not prove so simple a matter.

The Massey-Ferguson package deal includes a pay increase and a procedure agreement with the unions establishing a national joint council as the last stage in the grievance machinery. It will also be the body for handling disputes concerning men at more than one factory.

All this, admittedly from one of the most prosperous and go-ahead of big firms, must have a definite influence on the course of wages and hours negotiations for the engineering industries generally.

Of altogether greater weight is the 40-hour winter week agreed for a quarter of a million workers in civil engineering. At an estimated cost of some £10 million a year the employers have now given a 40-hour week in the months of November, December, January and February and 1½*d* an hour more which will compensate for an annual average week of 42¾ hours, in place of 44 throughout the year now. The new system, which will give overtime pay at time and a half for the first four hours instead of the present time and a quarter for the first two hours and time and a half after that, will operate from February. In effect the winter week will begin in civil engineering next November.

Apart from its quotability over the bargaining table by other engineering unions, the agreement has its effects on other building employers who are engaged in negotiations with representatives of the million building trades workers on their claim for 4*d* on the hour and a shorter working week.

A substantial concession here would increase building costs both industrially and by the house builder. A 2*d* an hour increase would, on some estimates, put £20 on the cost of a three-bedroomed house.

If, as hours are reduced, a running provision of tea and possibly snacks is to replace the tea break, the automatic vending machine industry, now growing apace in the hands of a Hawker Siddeley subsidiary and other companies, may gain substantially.

The Right Homes for the Aged

One of the least known facts of the housing developments in the late 1950's was the trend in council housing away from provision for families and towards purpose-built homes for the old. From 7 per cent each year at the opening of the decade, the proportion of council homes built specially or elderly tenants rose to more than 25 per cent by the end of 1959.

Now Mr. Henry Brooke, Minister of Housing, has declared that he may want to see the figure going still higher, even when it passes 30 per cent. The greater the number of such homes being provided by local authorities the greater the chance for architects and others to usefully produce homes and equipment suitable to the needs of the retired. The commercial difficulty is that advancing years are not conducive to serious spending on major items like gas stoves, central heating systems and refrigerators.

One valuable development, although it has been seized on by not always well informed critics, has been the old people's flatlet. Often with a warden in attendance, these can provide the essential requirements for independence while freeing the really aged from the troublesome and dangerous demands of a garden and yet not shutting the old people off from contemporaries.

The Clubbable Engineer

How many engineers want their own residential club with full amenities, and presumably the fees to pay for it?

The question arises from suggestions made in a letter published in the January issue of the *Professional Engineer*, the Engineers' Guild journal. Their correspondent suggests that there is an interest in such a club, for chartered engineers who are Guild members, since he believes the Royal Charters of the Institutions do not allow them to set up as club proprietors.

The difficulties of the traditional London clubs are well enough known for doubts about the possibility of the venture. But if the straits of the London clubs are because of the movement of wealth away from their traditional supporters it may be that some of it has moved towards those who could be members of a chartered engineers' club. More pessimistically it is possible to consider the private car as the villain in the decline of the clubs and this would certainly limit the number of engineers not able to get home at night.

In the enormously larger United States of America, where even the airplane has not yet eliminated distance, New York boasts a professional engineers' club, close neighbour to the building housing the American engineers' societies. But the correspondent of the *Professional Engineer* is considering clubs "in every town where engineers are fairly numerous," thus giving younger engineers the opportunity to meet senior members of the profession, and, perhaps by making arrangements in hotels, providing club facilities for those away from home.

Not every engineer wants to spend his leisure time with others of the same breed, and a definite advantage from mingling with other professions and occupations flows from membership of non-occupational clubs, and even from staying in hotels. Since there is one Engineers' Club in Britain, in Albert Square, Manchester, its experience is relevant.

The hon. secretary, Mr. E. Wilkinson, told ENGINEERING that since its foundation in 1912 the club has not moved in the direction of providing bedrooms. It provides assembly rooms from the 140 strong dinner or the 250 audience lecture, down through several smaller rooms to those for a meeting of 20 people.

The club's 600 members are largely professional engineers and associated professional men in the engineering industries. About 15 per cent are not engineers. This leavening is made up of accountants, solicitors and others.

Each day some 150 members and their guests have lunch at the club.

If there is ever a chain of clubs, or a London club, presumably near Victoria Street, it will need a name. Perhaps it will be the Feedback.

Nuclear Science Teaching Equipment

Atomic physics is currently being taught to an increasing extent in West German schools. Great importance is attached to the use of practical experiments and demonstrations during teaching, and suitable equipment is available commercially. Young Germans now benefit from this type of instruction in schools similar to grammar and secondary modern schools in this country.

Even the non-scientist has the principles of nuclear radiation demonstrated to him. The need for everyone in this modern age to have some idea of what the new science is about is appreciated in Germany. The West German government has made available a sum of over a million pounds to schools and colleges specifically for nuclear science teaching equipment.

These were some of the points made by Dr. K. Hecht, a nuclear physicist from Cologne, speaking at the annual meeting of the Science Masters' Association held at Southampton University. At this meeting, in addition to lectures and visits, various exhibitions were arranged including a special exhibition on atomic and molecular structure and nuclear energy. Equipment was shown suitable for all stages of instruction from the simple to the advanced. Among the organisations and manufacturing firms exhibiting were Vickers Armstrongs (Aircraft) Limited, of Swindon, whose nuclear division exhibited for the first time a sub-critical training reactor and a small laboratory neutron-source assembly.

It was apparent from this exhibition that industry is playing its part by providing suitable nuclear training equipment. If British students are to be at least as knowledgeable and experienced about the possibilities and limitations of nuclear radiations as those trained abroad, then active steps should be taken to provide demonstration equipment in most schools, technical colleges and universities. A gramme of practice is worth a ton of theory.

The Truth about Balance Sheets

The accolade of worthwhile practice may be given by engineers to the companies who, like the Solartron group, plough back the profits and push ahead with research and development. But this cuts no ice in the City, where not even profits count and where the dividend is what matters.

The representative of the City and of the investor explained his point of view to the recent British Institute of Management meeting on interfirm comparison. And that view was quite simply that he would like a minimum yield from big companies of 15 per cent and from smaller private companies of 30 per cent.

Examples given to the conference from the electrical and food industries related the parallel growth of assets and of profits. Cash balances were said by one researcher to have been a significant pointer. Often the firm with the largest cash balance was the least profitable. It did not follow that borrowing money was the high road to success.

The proposal was made, alarming at first sight but it was supported, that the managing director, the works manager, the investor, and others should all have different definitions for "the capital employed." This could perhaps explain some of those interesting rows that occur at certain annual meetings when shareholders and directors appear not to be speaking the same language. The return on capital, about which a lack of knowledge has even led to defeat at the hands of take-over manipulators, was held to be a valuable measurement to take.

Some of the adjustments needed to bring a business into line with the appropriate ratio of capital employed to profit might be painful, but the conference plainly believed that the adjustments should be made.

For the purpose of managerial decision making, Mr. L. Taylor Harrington, of the BIM was provocatively sure that the balance sheet could be regarded as a misleading document.

Such discussions of profit, dividend, capital investment and cash resources carry with them the risk that those taking part will be disabled in their critical faculties by the very act of being one of a group whose overt aim is material success. Industry and the national wealth at large could lose through devotion to a high dividend return as the be-all and end-all of a company's existence. Industry would lose if development of new processes and products unprofitable in the long early stages—were made impossible for the small firm and driven solely into the research departments of the few very large groups.

The Master Builder

Dr. Cecil Hart, Rector and Principal of the Nigerian College of Arts, Science and Technology since 1954, is to succeed Mr. G. H. A. Hughes as director of the London Master Builders' Association.

In the six years of Dr. Hart's rectorship, the Nigerian college has grown from 150 students to more than 1,000, with three branch colleges. Its courses are associated with the Royal Institute of British Architects, the Royal Institution of Chartered Surveyors and the Institutions of Civil, Mechanical and Electrical Engineers.

Active in building research throughout his career, Dr. Hart represented India at the building research international conference in London in 1951.

After completing his education at University College, London, Dr. Hart went to Surrey County Council as an engineering assistant and later returned to University College as lecturer on mechanical engineering and surveying.

After war service, surveying in a number of war theatres with the Royal Engineers, he was given the newly set up chair of surveying and photogrammetry at University College. Before going to Nigeria, Dr. Hart had, from 1949, been Vice-Chancellor of Roorkee University, which took the place of the well-remembered Thomason College of Engineering.

Durgapur: A Plant for India's Growth

Durgapur Steelworks, India, now partly in operation, is an outstanding example of a type of export of increasing importance—the complete factory and large-scale arrangements for training the men who will eventually run the works.

Durgapur is big—big by any standards. Designed for an annual production of one million ingot tons of steel, the works stand on a site of 1,500 acres, with a boundary wall seven miles long; when complete, it will employ about 10,000 manual workers and 650 staff. It will also have cost £105 million, about half of which is being spent in Great Britain and the remainder in India. From the point of view of British exports Durgapur represents the biggest single order ever placed with a British firm.

But all integrated steelworks are big; modern steelmaking processes need large and costly plant. Size, though it is an impressive feature of Durgapur, is not the most important one. Durgapur is a symbol of what can be done by cooperation between two nations, Britain and India, and between the various companies whose products and services go to make up the complex modern steelworks. This is not the first time that Britain has exported a complete factory, nor is Britain the only nation engaged in this very important type of export work. Russia is at present occupied on the construction of a steelworks for the Indian Government at Bhilai, and Germany is carrying out a similar project at Rourkela.

Each of these works will have the same capacity as Durgapur, one million ingot tons a year, and all three works will be managed on behalf of the Indian Government by Hindustan Steel Limited. Durgapur, the last of the three contracts to be placed, thus presented Britain with both an opportunity and a challenge.

FINANCE

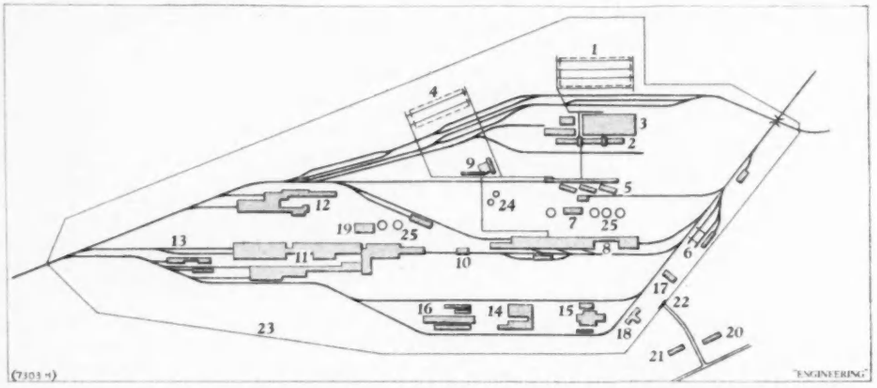
Arising out of the Colombo Plan, Durgapur Steelworks were conceived as a "package deal": a complete steelworks, designed, built, erected and handed over to the owners in full working order.

Two major problems had to be solved right at the beginning of the project. In the first place, means had to be found for raising the very large sums of money involved. For the rupee expenditure the Indian authorities made the appropriate arrangements, and the necessary sterling was made available as a loan, with the assistance of the British Government and some of the leading British commercial banks. Secondly, there was no single British firm which made all the plant and machinery required for such a large undertaking. This problem was solved in the same way as for other contracts of a similar magnitude; a consortium of firms, some of them normally competitive, was formed for the purpose under the name of the Indian Steelworks Construction Company Limited (ISCON). This company coordinated the work of preparing tenders and specifications, which were duly approved by the Indian Government, and the contract for the construction of the works was signed in October 1956.

On the basis of an annual production of one million ingot tons of steel, the works have been designed to produce:

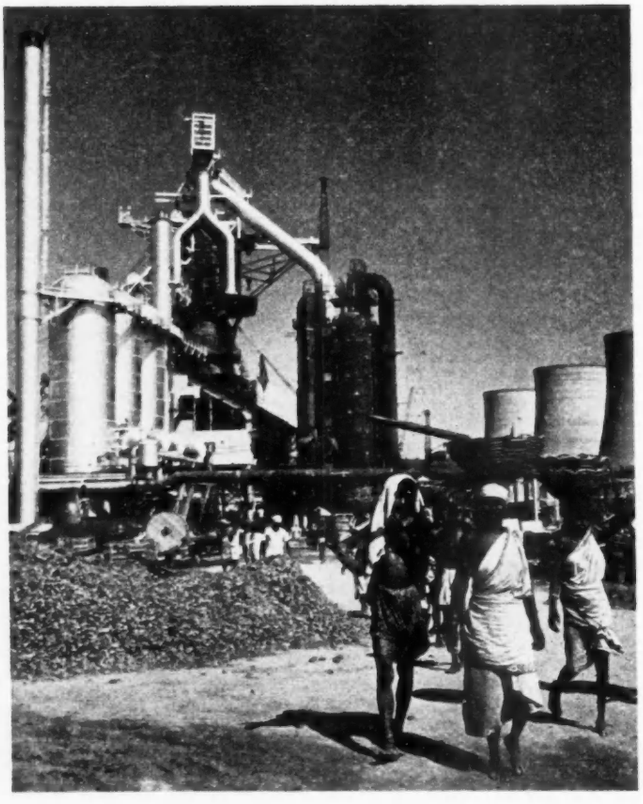
Semi-finished Products	
Heavy forging blooms	10,000 tons
Forging blooms	30,000 ,,
Forging billets	60,000 ,,
Re-rolling billets	150,000 ,,
Finished Products	
Merchant bar sections	240,000 tons
Light and medium sections	200,000 ,,
Sleeper bars	60,000 ,,
Railway wheel sets	50,000 ,,

The site for the works at Durgapur, 120 miles from Calcutta, has all the necessary raw materials within easy access, water is available in the required quantities, and there are established communication systems in the area. Coal will be drawn from a radius of 40 to 80 miles, and iron ore from a radius of 200 miles. Limestone and dolomite are available locally.



(Above) Simplified layout of Durgapur Steelworks.

1. Coal storage and blending
2. Coke oven plant
3. By-product plant
4. Iron ore storage and blending
5. Blast furnace plant
6. Pig casting plant
7. Power station
8. Steel making plant
9. Lime and dolomite plant
10. Ingot stripping building
11. Rolling mills plant
12. Wheel, tyre and axle plant
13. Sleeper plant
14. Central engineering maintenance department
15. Foundry
16. Central stores
17. Oxygen plant
18. Central garage
19. Main electrical sub-station
20. Main office block
21. Central laboratory
22. Main works gate
23. Boundary wall
24. Gas holders
25. Cooling towers



(Right) No. 1 blast furnace shown here nearly finished.

As being constructed the works will include a coke oven plant of 234 ovens, arranged for by-product recovery; three blast furnaces each of 27 ft hearth diameter and capable of producing about 1,250 tons of iron per day; and a steelworks with eight basic open-hearth furnaces, seven of 200 tons capacity and one of 100 tons. Steel rolling plant will include a 42 in billet mill, a 32 in intermediate mill, a 26 in medium section mill, a continuous merchant mill and a continuous billet mill. A sleeper bar plant and a fishplate plant are also included. There will be a railway wheel and axle mill, ingots for the wheels being supplied by the 100 ton furnace in the melting shop, and the billet mill will provid the billets for axle making. To complete the plant there will be a central engineering maintenance shop and a power station, which will provide the blast for the blast furnaces. This power station will also be capable of generating emergency power for all essential works services in the event of an external mains supply failure.

PLANNING

Completion of the works is scheduled for April, 1961, but the whole project has been planned for construction in four stages, so that the productive capacity of various departments can be used as a source of revenue as major items of equipment are completed in turn.

Stage one, which was scheduled for completion in October, 1959, is now finished. It includes: one coke oven battery; one blast furnace; the foundry and central engineering department; and part of the power station. This stage, though representing only one-quarter of the complete project, is of considerable importance, as it is at this point that the works first start to produce iron. It was, accordingly, marked by an official opening ceremony, performed on

29 December, 1959, by Dr. Rajendra Prasad, President of India. Stage two, scheduled for completion at the end of April, 1960, comprises the second coke oven battery, second blast furnace, part of the steelworks, part of the rolling mills and the remaining section of the power station.

In stage three the coke ovens, blast furnaces and rolling mills will be completed and a further part of the steelworks will be brought into operation by the end of April, 1961. Finally, the work will be brought to an end in stage four, which covers the completion of the steelworks and the wheel and axle plant. This is scheduled for 31 July, 1961.

Construction of any very large undertaking involves detailed planning, and in this case it necessitated the coordination of the work of all the British firms in ISCON, of many British sub-contractors, and of the Indian firms who are contributing site work and materials. In the month following the signing of the contract the first contingent of British engineers arrived on the site, and work began on clearance and levelling for the civil engineering work, which was extensive, as considerable piling was necessary. Since then the labour force has been built up until, at times, about 33,000 workers have been employed. Supervisory staff is both Indian and British, but only about 400 British technicians have been resident at Durgapur, far fewer than the German and Russian nationals engaged at the other two Indian steelworks sites. In comparison with these other undertakings, Durgapur has, in fact come out very well in all respects.

There is never, in such a large project, any single dramatic moment when everything is complete and ready to go to work, but there are countless occasions when an item of equipment must arrive on site according to schedule, fit in as planned, and work as designed. If only one such item fails in one particular it can upset the entire programme. It is therefore a source of satisfaction for both the Indian and the British contractors engaged on the work to be able to report that it has proceeded smoothly and everything is on schedule; some items have, in fact, been brought into operation well before the planned date.

TRAINING

It is not enough simply to build and equip a modern steelworks and hand it over to the owners ready to operate. Steel making involves many trades and professions, and many different kinds are needed to run a large works.

To assist in the technical staffing of the works the British Government have, under the Colombo Plan, made available the necessary funds for training some 300 men from India whose job it will be to run Durgapur. Training in engineering is being carried out primarily in the works of the British engineering contractors building the plant, and the British Iron and Steel Federation have undertaken to provide training in works operation and plant engineering.

The scheme is being spread over two years, and already more than 150 young Indians have arrived in Britain. Divided between the principal engineering and steelmaking centres in England, Wales and Scotland, the men are spending periods ranging from seven months to a year in works of different kinds, according to the type of job they will do on their return home. If a man is to be employed on steel plant operation, his time in this country is spent entirely in a steelworks. If, on the other hand, he is going to be a maintenance engineer, his training is divided into two periods, one with a company making steelworks equipment and the other in a steel producing plant. Each training course is prefaced by a week's introductory period, arranged by the British Council (which is also responsible for the accommodation and general welfare of the trainees), to give the men a general idea of the environment and the industry in which he will be working. Arrangements have also been made for the trainees to take part in some of the special courses run by the British Iron and Steel Federation at Ashorne Hill, Leamington Spa, for foremen, departmental managers and other works personnel.

Training does not end, of course, with the special scheme at present being operated in Britain. Technical training facilities are being expanded in India, men are being sent to other countries besides Britain, including the USA, and Hindustan Steel Limited have worked out a comprehensive scheme for the recruitment and training of operators and mangement for all three works under their control.

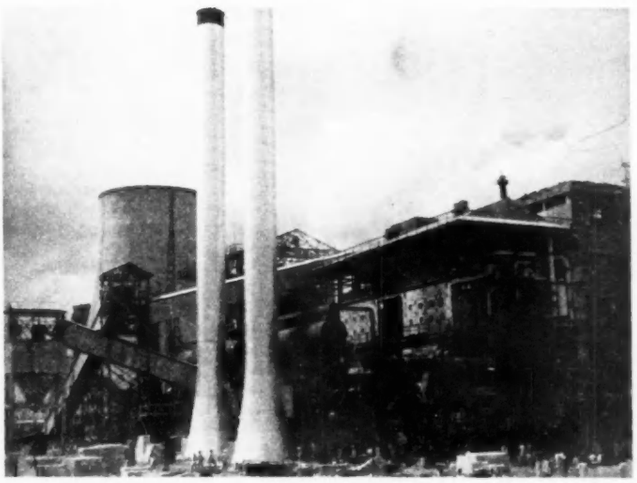
So the two programmes go hand in hand; the works are being built and the men are being trained to operate them. A small number of British technicians will remain at Durgapur for a time after the works are completed and handed over, while the plant settles down to normal production, but as soon as that condition is reached, the works will be entirely Indian run and managed. It is a normal arrangement, anyway, for representatives of the plant builders to be present during the running-in period.

India has recognised that to raise the standard of living of her great population and to strengthen her hand in world affairs, industrialisation is essential. Durgapur is a solid symbol of the way in which her aims are taking shape.

ISCON CONSORTIUM

The companies forming the ISCON consortium, and the principal items for which they are responsible are:

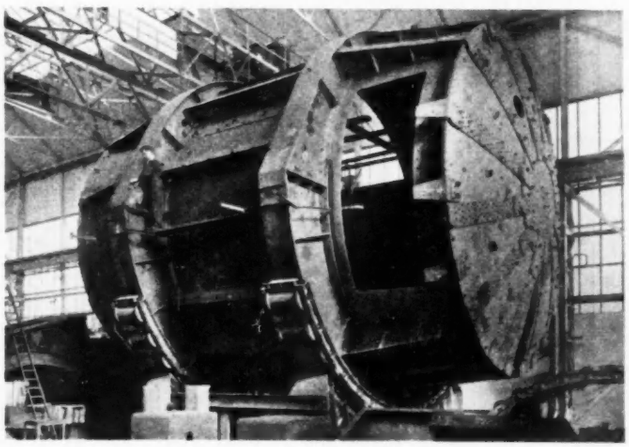
Cementation Company Limited	All civil engineering except for coke ovens and power plant
Head, Wrightson and Company Limited	Blast furnaces and iron making plant
Davy and United Engineering Company Limited	Rolling mills, wheel and axle plant, foundry and engineering maintenance shop
Simon-Carves Limited	Coke ovens, by-product plant, steam and gas distribution
Wellman Smith Owen Engineering Corporation Limited	Open-hearth furnaces, steelmaking plant, cranes, soaking pits
Sir William Arrol and Company Limited	Cranes and structural steel
Cleveland Bridge and Engineering Company Limited Dorman Long (Bridge and Engineering) Limited Joseph Parks and Son Limited	Structural steel
British Thomson-Houston Company Limited English Electric Company Limited General Electric Company Limited Metropolitan-Vickers Electrical Company Limited	Electrical plant
ISCON Cable Group (Siemens Edison Swan Limited and Pirelli General Cable Works Limited)	Electrical cables



(Left) Boilers and fuel handling plant are building at the same time.

(Below left) Steelworks equipment—this is an 80 ton hot metal mixer—is being erected in British engineering shops.

(Below right) Trial erection of the rolling mills is also taking place simultaneously.



Mechanical Efficiency of Piston Engines

Measurement of losses in piston engines is complicated by the number of variables involved. Pumping losses may be as much as one-third of the total.

By Gordon Wilkins

The publicity given to the NSU-Wankel engine, which has no moving parts beyond the geared rotor and its central shaft, directs renewed attention on to the mechanical losses inherent in the conventional piston engine. Assessment is complicated by the difficulty of making accurate measurements and the various methods in use have been reviewed in an MIRA report*. Some notes on these methods are given below.

Determination of mechanical efficiency, either from indicator diagrams which enable i.h.p. to be compared with b.h.p. or by other methods which permit friction losses to be expressed in friction m.e.p., is complicated by the many variables which can affect the results. Among them are i.m.e.p., compression ratio, ratio of maximum to mean pressure, maximum pressure, r.p.m. and mean piston speed, temperatures and type of lubricant used for bearings and piston-cylinder assemblies; also the number, type and pressure of piston rings, and the piston ring pressure as affected by cylinder pressure.

TEST METHODS

(1) Among the methods employed for determining mechanical losses, the use of indicators is attractive as a means of showing losses under firing conditions, but the difficulty of obtaining accurate records at high speeds is well known. Gish and his collaborators claim to have evolved a new method which gives accurate phasing of indicator diagrams to $\pm 0{\cdot}1°$ by a high-sensitivity contact-free balanced-pressure indicator and an "average cycle" counter which detects pressure-volume relationships in the presence of the large cycle to cycle variations in peak pressure which are known to occur. Tests at compression ratios of 7 and 12 to 1 showed the friction m.e.p. as 21 per cent greater than motoring friction as the throttle was opened and 28 per cent below motoring friction when the engine was idling.

(2) For motoring tests, Ricardo claims that at low compression ratios, up to 6 to 1, the increase in air work when motoring just about balances the reduction in friction loss under motoring conditions. At higher compression ratios, he believes motoring tests may over-estimate total losses by up to 20 per cent, but the variety of expedients used to adjust the results to represent firing conditions illustrate the limitations of the method.

The following factors are noted as contributing to the differences recorded under motoring and firing conditions:—

(i) The higher temperature under firing will reduce viscous friction caused by shearing of the piston-ring-cylinder oil film.

(ii) Changes in oil supply and jacket temperature both affect piston and ring friction.

(iii) Cylinder pressure affects friction losses through changes in side thrust of pistons against cylinder walls and radial loading of piston rings.

(iv) It has been shown that pressures in the top ring groove are closely related to cylinder pressures and the mechanical condition of piston rings and grooves has an effect on the pressure existing behind the lower rings, but this has not been investigated on small-bore high-speed engines.

Ricardo suggests that there is an increase in ring friction between motoring and firing equivalent to 2 to 2·5 lb per sq. in m.e.p. for compression ignition engines and 1·5 lb per sq. in for spark ignition units. The coefficient of friction between piston and rings and walls and the condition of the lubricant itself may be responsible for big variations in the part of the barrel which is exposed to temperatures of over 2,000° C.

(3) The Morse test, by cutting out one cylinder, may affect the performance of other cylinders through the inlet and exhaust systems and, for the reasons quoted above, friction in the cylinder being motored may be different from that under firing conditions.

(4) The Willans line method, in which the line of gross fuel consumption is extrapolated to cross the b.m.e.p. axis, thus giving the power required to drive the engine without producing any power, i.e., the power loss. It is only suitable for compression ignition engines.

(5) Taylor's method was evolved primarily to measure piston friction by motoring an engine with constant gas pressure applied to the pistons. Valves are removed and their stems plugged, external openings of inlet and exhaust manifolds are closed, oil and water pumps are driven separately. But pressures and temperatures do not correspond to firing conditions.

(6) In Moss's method the carburettor is removed and compressed air is supplied to the inlet from a tank, while the exhaust is connected to another. The valves operate normally and cyclic pressures approach normal.

(7) For Dutcher's method the inlet and exhaust are connected together and the two pressurised from an outside source. Dutcher himself has pointed out that even a conservatively rated engine may have a considerable mean effective pressure above the pistons throughout the four strokes of the cycle. MIRA has elaborated this test, using an electric dynamometer, while loading pistons, rings and bearings with a gas load which varies during the cycle in the same manner as in actual firing. This is believed to give the best available results in the absence of reliable high speed indicator diagrams.

Effect of Engine Speed.—Ricardo argued that the highest possible mechanical efficiency is obtained by using low piston and rotative speeds because the greater part of the friction is due to inertia of the reciprocating parts, which increases directly as the piston speed and as the square of the rotative speed. To reduce heat losses and obtain reasonable power from a given size of cylinder he preferred to increase piston speed by using a long stroke. He regarded a high piston speed combined with a short stroke, and therefore a high rotative speed, as the very worst condition from the point of view of mechanical efficiency, but this is the type of engine which is for other reasons becoming increasingly popular today.

There are two independent systems of friction forces operating, (*a*) that of the journal bearings, i.e. the rotating system and (*b*) the pistons and rings or the sliding system. Ricardo states that the resistance to shear, or viscous friction, increases very nearly as the square of the rotational speed.

Effect of Lubricant Viscosity.—A great deal of literature exists to show the benefits which have been obtained from the use of thinner oils, both in motoring tests and in service tests on the road. Tests at the MIRA proving ground have shown fuel consumption savings of 5 per cent from the change from SAE 20 to SAE 5 W oil, both on commercial vehicles run at relatively low speeds and on a 2-litre car run at higher speeds. There is also considerable data on the experience with London buses where the change from SAE 30 to SAE 20W reduced fuel consumption by an average of 2·6 per cent without any adverse effect on performance or engine life. Others have recorded savings between 5 and 18 per cent for cars and 7 and 10 per cent for commercial vehicles by changing from SAE 30 to SAE 5 grade oil. As another illustration of the effect of oil viscosity a MIRA report has shown that a change of 30° C in water jacket temperature on a compression ignition engine gave a saving of about 13 per cent in friction horsepower at an engine speed of 2,400 r.p.m. in bench tests.

Effect of Load.—Even though total engine power loss increases with load, mechanical efficiency also increases, but the increase in power loss is only small when compared with the corresponding increase in power output. Ricardo states that viscous friction increases rapidly with speed, but is nearly independent of gas loading; and that piston ring friction is nearly independent of speed, but nearly proportional to gas pressure.

Effect of Compression Ratio.—Quoting Ricardo again, increase of compression ratio on spark ignition engines raises both compression and peak pressures. The higher pressures involve heavier loads and greater friction, more especially ring friction and more important, the higher pressures call for heavier moving parts and larger bearing areas if the same safety margins are to be maintained.

MIRA argues that the large changes in power loss which result from oil viscosity changes indicate that film lubrication exists over much of the friction surfaces, but the increase in frictional resistance with increased loads could be regarded as evidence of partial boundary lubrication.

Motoring tests, with step by step removal of components are the chief method by which investigators have sought to trace the distribution of power losses due to friction throughout the engine, but the objections to motoring tests cited above apply here too; furthermore, the removal of a component alters the distribution of forces acting on the remainder.

PUMPING LOSSES

On crankshaft journal bearings, the work of Dr. A. Fogg is cited suggesting that a length: diameter ratio of 0·5 may minimise that part of the mechanical loss due to bearings, and it is considered that there is still scope for reduction of friction losses by careful design and choice of bearing materials. One report shows valve mechanism and accessory drive gear as accounting for 2·5 and 5 per cent respectively of total friction loss. On a high speed motor cycle engine the valve gear accounted for 4·6 per cent of friction horse-power.

Pumping loss is an important factor, estimated by some investigators to absorb as much power as piston and ring friction, or one-third of the total power loss. Design of the carburettor, inlet manifold and intake passages all affect the power loss and Ricardo considers a mean gas velocity of about 240 to 260 ft per sec to be the limit for reaching maximum power output from petrol engines and 210 ft per sec from CI engines. Pye points out that pumping loss can be reduced and volumetric efficiency increased to a greater extent by changing the suction pressure towards atmospheric pressure than by a similar reduction in exhaust back pressure. Judge estimates that at mean inlet gas velocities of 250 ft per sec pumping losses cost about 9·5 lb per sq. in m.e.p.

Of the auxiliaries, the fan and radiator probably offer the most scope for power savings. By pressurising the radiator a reduction of radiator size or fan power can be obtained. A fairly simple solution is a thermostatically controlled electromagnetic clutch which disconnects the fan when it is not required. This is now available on all Peugeot models and on some Ferraris. Fan design is also capable of improvement. One report has emphasised the importance of small clearances between fans and their ducts. At constant air flow the fan power requirements may rise by 75 per cent when the gap is increased from 0·1 to 2 per cent of fan diameter.

* *The Mechanical Efficiency of I.C. Engines*, Available from Motor Industry Research Association, Lindley, Warwickshire. (10s 6*d*)

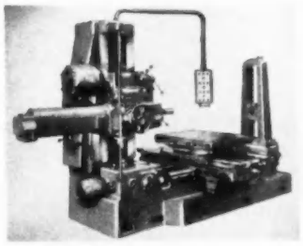
HORIZONTAL BORER

Fine Tolerances

AVAILABLE in this country for the first time is the Italian Azeta horizontal boring and milling machine.

The model GL80 is a powerful machine capable of working to fine tolerances. The spindle is driven by a 10 h.p. motor. The full motor power is utilised as the headstock is rigidly clamped to the column by cross beams and locking bolts. Separate 2½ h.p. motors drive the traverse and rotate the worktable.

The carriage is supported by two main bedways and by two auxiliary ways to give full width support for the cross travel. Anti-backlash devices are fitted to most of the moving parts. To prevent overrun, adjustable endstop micro-switches are fitted to all movements, and in addition the table rotating motor cannot be started while the table is locked. All the electrical controls are interlocked so that contradictory motions cannot occur. An adjustable torque clutch prevents damage to the feeds if the table should jam.



All electrical controls are operated from the pendant, the control circuits being run at 24 V to avoid accidents. Forced lubrication supplied from five Bosch pumps is used throughout. All horizontal ways and driving screws are protected by stationary steel covers which do not restrict the amount of travel on the ways. The machine will do facing work up to 30 in diameter and the larger model has a table measuring 35 in by 47 in and traverses 61 in and 59 in. Vertical movement is 35½ in. Threads can be cut from 2 to 96 T.P.I. using the incorporated apparatus. The 8 rates of feed are obtained by differential gearing. *Monks and Crane Limited, Garretts Green Lane, Birmingham, 33.*

FAN HEATER

Thermostatic Control

A RANGE of fan heaters fitted with thermostatic control has been introduced for general use in the office or factory.

There are seven sizes in the range, the smallest having an output of 5 kW (equivalent to 17,000 Btu per hour) and the largest one 40 kW (136,000 Btu per hour). They will run from normal electricity supply mains.

The open-wire spiral-form element operates at black heat at all conditions and so has a long life. The thermostat can be hand set to safeguard the element if over heating should occur. It is possible to run the fan without the heater and so circulate cold air during warm weather. A detachable filter can be fitted to clean the air passing through the unit.

The direct starting motor is fitted with resiliently mounted ball bearings. The fan unit is designed to eliminate vibration as far as possible, and thereby to reduce the chance of short circuiting. The units are fitted with suspension straps

for safe fixing and wire mesh screens to protect the elements. At the front are louvres that can be adjusted to deflect the air stream at the required angle to cover the area to be warmed. A sheet metal case houses the whole unit and the price is low. *General Trade Equipment Limited, 89-92 Seymour Place, London, W1.*

FREQUENCY METER

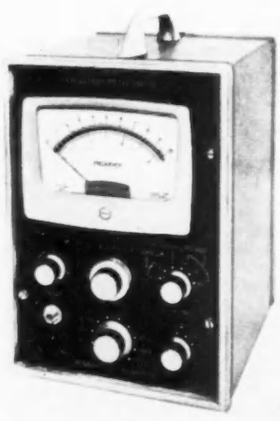
3 Cycles to 300 kilocycles

THE type TSA501 frequency meter is a transistorised analogue instrument with a direct reading coverage from 3 c/s to 3 k/cs in ten steps.

Each of the ranges is capable of expansion by 3 or 10, and extra damping of the meter is available on the lower ranges. The accuracy is largely independent of the input wave form. The range of amplitudes of the input can be from 200 mV rms to 250 V rms for sine waves, or from 0·5 V peak to 500 V peak for pulse forms.

The input impedance of the instrument is 250 kilohms shunted by a 50 pF condenser. Operation can be from an internal or external 12 V battery, or from 200-250 V 50 c/s, or 100-125 V 50 c/s, mains supplies. The current consumption is 70 mA. Overall size of the instrument is 10 in by 7 in by 8 in deep.

At the rear of the instrument is a socket for use in conjunction with a photo head and light source for the measurement of rotating speeds. At the rear there is also provision for using a



remote indicator or recorder connected by another socket. *Venner Electronics Limited, Kingston By-Pass, New Malden, Surrey.*

THREAD CUTTER

Up to 6 in Diameter Tubes

NEW additions to the Landis range of screw cutting machines are the two that go to make up what is to be called the series 13G.

The first machine, which is illustrated in its standard form, is the 13GR. This is fitted with a standard radial type die-head capable of cutting threads on tubes from ½ in diameter up to a maximum of 6 in diameter. Alternatively threads can be cut on bolts ranging from a minimum of ½ in diameter up to a maximum of 3 in diameter.

The diehead of the machine incorporates a mechanism for cutting tapering threads and an instantaneous release and close lever for the diehead. It is also possible if desired to fit this machine with a leadscrew control to drive the saddle.

The 13GT machine is fitted with a 6 in all steel tangential diehead having a capacity for tubes from 2½ in up to 6 in diameter. Automatic release is incorporated in the diehead. An alternative

4 in diehead can be fitted to take from ½ in to 4 in diameter tubes or ½ in to 3 in diameter bolts.

Common features of both machines are a substantial cast iron bed with a pick-off gear headstock. This permits a choice of four spindle speeds ranging from 7 to 18 r.p.m. The saddle is of the narrow guide construction having a self centring vice that incorporates a hammer-blow handwheel to eliminate operator fatique. *Landis Machine-Malden Limited, Hyde, Cheshire.*

BENCH GRINDER

Compressed Air Operated

A NEW compressed air-operated grinder, the 3190 M, has been introduced as a bench mounting unit.

The tool has capacity for a 6 in diameter wheel with a face width of 1 in. The free operating speed is 4,500 r.p.m. The total height of the unit is 9 $\frac{1}{16}$ in and the weight including the guard is 12 lb. The diameter of the inlet connection is ¼ in and the connector has a male British standard pipe thread so that it can be used with most standard compressed air fittings.

Power for the tool is developed by a vane type motor, a particular feature of which is a constant speed governor which maintains the wheel at the most efficient cutting speed from no-load to full load and is said to eliminate the possibility of over speed when the wheel is running free.

A heavy valve spring used with a loose fitting valve prevent the valve from being jammed by any foreign matter in the air supply, and a neoprene O-ring gives a leakproof valve seal.

The grinder has a drilled base plate that makes it suitable for attaching to portable compressor units for tool maintenance, as well as for mounting on a bench for general workshop use. It is robustly built and the guard gives proper protection of the wheel. The power developed is sufficient for all normal grinding purposes, such as touching up drill steels and the points of rock breakers. *Consolidated Pneumatic Tool Company Limited, 232 Dawes Road London, SW6.*

MOTOR STARTER

Hand or Automatic

THE latest addition to the Dupar range of motor starters is fitted with a selector switch for hand or automatic operation.

Two versions are available, TFW and TFK, respectively with or without reversing contactors. They are designed for direct-on-line starting motors up to 7½ h.p. with 440 V supplies. Control can be by two or three wire systems. A thermal overload gives protection for high currents and also for single phasing. With zero current in one phase tripping will occur at 70 per cent of the calibrated value in the other two phases. Balanced overload causes tripping at 115 ± 10 per cent of the calibrated value. Compensation is provided against changes in ambient temperature.

Control buttons, including the reset button, are mounted in the front cover and indication of running is given by a red pilot light. Optional extras include isolating switch, HRC fuse links and ammeter. *Dewhurst and Partner Limited, Inverness Works, Hounslow, Middlesex.*

Physical Society Exhibition

The 44th exhibition of the Physical Society closed on 22 January last after having proved as popular a meeting place for "backroom boys" as ever. The Horticultural Society's Halls were well filled with exhibitors and visitors, indeed at one time attempts were made to institute one way systems along the aisles in an endeavour to keep an open passage. But congestion continued. Thirteen firms are thanked by the Society for standing down to relieve pressure on space.

The *Handbook*, which runs to over 350 pages apart from advertisements, lists 186 exhibitors on 140 stands, and the products range from a bone marrow cooler to an interferometer for measuring the brightness of stars. As so many of the items had only reached the prototype stage, information about them and their practical application was scant but the brief descriptions in the *Handbook* serve as a guide to future possibilities and paths of development. Many of the items approaching the production stage promised to be useful tools for engineers in metrology, and control systems or as components to improve machines.

During the course of the Exhibition, three discourses were given. They were entitled "Some Reactions of the Human Body to the Stresses of High Performance Flight," by Flt. Lieut. J. Billingham; "Atomic Time," by Dr. L. Essen; and "Recent Advances in Solid-State Physics," by Dr. D. A. Wright.

Some of the exhibits were described in our issue of 22 January and some more are given here.

SPEED INDICATOR

Down to 0·1 r.p.m.

INSTANTANEOUS measurements of speed down to 0·1 r.p.m. can be made by a new form of tacho generator invented by Professor F. C. Williams, F.R.S., of Manchester University.

A particular feature is that no brushes or commutator are used so that mechanical inaccuracies and friction losses are avoided. The output is a direct current.

The principle of operation is the determination of the speed of a conducting cylinder by the measurement of the quadrature field set up as it passes through a primary magnetic field. The quadrature field is sensed by a second harmonic type of flux detector and the output from this last is used to create a null quadrature field by feeding back its output to feedback windings. The detector thus works in a region of low flux density and its output can be taken as linear over a small working range. The device is intended for use in the computing and industrial fields. *Vactric (Control Equipment) Limited, Brunel Road, London, W3.*

EXTENSOMETER

Using Moiré Fringes

A PROTOTYPE recording extensometer developed in conjunction with the Aeronautical Directorate Laboratories uses Moiré fringes for measuring the extension of the specimen that is being tested.

The instrument is primarily intended for the investigation of long term creep phenomena at high temperatures. The extension of the specimen is detected photo-electrically from the Moiré fringes produced by two small sections of diffraction grating.

In operation a four phase signal is fed to a transistor power amplifier which drives one axis of a pen recorder. A synchronous motor drives the other axis and the extension, greatly magnified, is automatically plotted against time to give a continuous recording.

The photo-electric detection of fringe patterns can also be converted to electrical impulses that can then be used to actuate transistorised decade counters which are fitted with edge-lit perspex numerical display. *Ferranti Limited, Hollinwood, Lancashire.*

POTENTIOMETER

High Discrimination

VERY high discrimination is claimed for a 4-dial potentiometer that reads in steps of 1 μV.

There are two sections of the instrument, the primary one having two dials giving 20 steps of 0·1 V and 100 steps of 0·001 V respectively and a secondary that also has two dials and gives 100 steps of 10 μV and 100 steps of 0·1 μV respectively. The primary section is standardised directly against a standard cell and the secondary against a section of the primary.

To provide for variations in the standard cell voltage the standardising section of the instrument includes a slide wire calibrated for standard cell voltages between 1·018 V and 1·019 V. The smallest subdivision on this slide wire corresponds to 10 μV so that it can be set accurately to within 1 or 2 μV. Current setting controls are provided for both potentiometers. Separate batteries are required for the two sections. *Cambridge Instrument Company Limited, 13 Grosvenor Place, London, SW1.*

OSCILLOSCOPE

Low Sweep Velocities

MODEL 1091 is a double beam oscilloscope with calibrated time base speeds giving low sweep velocities.

There are two indentical amplifiers for vertical deflection with a pulse corrected response from d.c. to 3 Mc/s and compensated attenuators giving sensitivity ranges from 50 V/cm to 0·5 V/cm. A preamplifier is included in the Y1 channel increasing the sensitivity to 5 mV/cm.

The time base is adjustable for either triggered or repetitive operation and covers from 0·2 μ sec/cm to 5 sec/cm on calibrated ranges. Continuously variable uncalibrated ranges have repetion rates from about $\frac{1}{2}$ c/s to 200 kc/s.

An X amplfier is fitted giving an expansion of $\times$ 1 or $\times$ 5 on calibrated ranges or continuously variable on the uncalibrated ones. Provision is made for feeding external sweep signals and the sensitivity is adjustable from 0·25 V/cm to 3 V/cm. *Cossor Instruments Limited, Cossor House, Highbury Grove, London, N5.*

PORTABLE MONITOR

Gamma Rays

THE Gammagraph is a transportable continuous recorder for detecting gamma radiation.

The instrument is powered by a 12 V 40 Ah car battery which is sufficient to operate it for a month without attention. It measures 30 in high by 9 in diameter. Three preset ranges cover radiation levels from natural background up to 10 mr per hour. The sensitivity is nearly quality independant from 60 keV up to 2 MeV.

It consists of an ionisation chamber mounted vertically on a sealed case containing the electrometer circuits and a clockwork-driven motor. Transistor circuits are used. Zero stability is better than 2 per cent of full scale over one month. The electrometer is a new development and will drive a 1 mA recorder to full scale by currents as low as 10^{-12} A. Power consumption of the complete instrument is less than 0·5 W. The weight is approximately 70 lb. *Electronic Instruments Limited, Lower Mortlake Road, Richmond, Surrey.*

MAP MAKER

Transfer of Detail

DESIGNED primarily for the transfer of information on to maps from aerial photographs, the Vertical Sketchmaster S 14 can also be used for detail transfer on drawings of different scale.

The instrument is stood over the map to be marked up, which is viewed simultaneously with the aerial photograph by means of a semi-silvered mirror. Scale changes and tilt adjustments can be simply made. Reconciliation can be effected between drawings whose scales differ within the range from 2·5 : 1 to 0·5 : 1. The instrument is light in weight and has a transport case.

The principle is that of the camera lucida. The aerial photograph placed on the platform is reflected by a large high quality mirror on to a smaller partially silvered mirror through which the map below is viewed at the same time. The photograph on the platform remains fixed but the distance and angle at which the map on the table is viewed can both be altered. *Nash and Thompson Limited, Hook Rise, Tolworth, Surrey.*

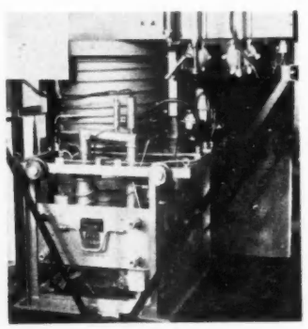
PUMPING GROUP

for Synchrotron

PUMPING systems for high energy accelerators require the reliable attainment and maintenance of the rated pressure coupled with remote and automatic control. The illustration shows one of the sets for a 7 GeV proton synchrotron.

The 24 in fractionating high speed oil diffusion pump is fitted with refrigerated chevron baffle and a full bore, high vacuum gate valve. This valve is so arranged and connected as to give controlled throughput during opening, and also to give rapid closing under fault, or emergency conditions. The diffusion pump is backed by a vapour booster pump and also a conventional mechanical pump, an arrangement chosen because it gives optimum performance in addition to size, weight, and cost advantages.

Automatic instrumentation and a control unit are included. Pressure, thermal and time control switches are fitted at various points on the pumping group and are sited to give correct automatic sequential operation of the pumps during the start up procedure, as well as ensuring that should any fault develop the unit will take the appropriate action to protect not only itself, but also the whole system that is being pumped. Many of the techniques, accessories and components used in the system also find applications in various other fields of general vacuum practice. *Edwards High Vacuum Limited, Manor Royal, Crawley, Sussex.*



FORCE BALANCE UNIT

For Pressures

A PRECISION force balance unit has been produced to give accurate and sensitive pressure measurements.

The form is robust and is designed to withstand modern aircraft operating conditions. It does not suffer from the inherent defects of a deflection instrument.

The essential components are a beam, supported by frictionless cross spring pivots, to one end of which is attached an inductive pick off. Also attached to the beam are a high precision spring and the pressure sensing capsules. Pressure change within the capsule causes the beam to deflect and this movement produces a signal output from the pickoff which is fed to an amplifier. The amplified signal is fed back to a servo that adjusts the tension of the spring until balance is restored. The system will operate from a 250 V, 50 cycle supply and the accuracy is $\pm$ 0·05 per cent. *Kelvin and Hughes Limited, Kelvin House, Park Drive, Wembley, Middlesex.*

ANGLE TRANSMITTER

Low Friction and Inertia

THE Synchrotel is an angular position transmitting element similar to the synchro but with extremely low friction and inertia. It can therefore be used where the driving power is very small, for example, in capsule operated mechanisms or clock escapements.

A three phase stator is used but a single phase winding takes the place of the usual rotor winding having its axis coincident with the spindle. The rotating member consists of an oblique section of a hollow aluminium cylinder on a light arbor, which is mounted on jewel bearings.

The rotor weighs 0·76 gm and its moment of inertia is 0·11 gm cm^2. The complete unit has a diameter of 1·312 in and a body length of 0·9 in. Synchrotels are generally used in servo systems with an ordinary control synchro as a receiving element. In certain cases, however, they may be used directly in back-to-back pairs. *Kelvin and Hughes Limited, Kelvin House, Park Drive, Wembley, Middlesex.*

Testing Space to Spare

Irradiation testing is the stream-gauging of nuclear power. At the first sign of a project a programme of material testing is initiated, just as stream-gauging stations are set up on a river at the first mention of a hydroelectric scheme. The urgency of irradiation testing arises from the need to prove the suitability of reactor components prior to installation up to the radiation dose expected during the component's service life. As reactors are built to last for some 15 to 25 years, the problem is formidable. In 1955 it was thought that lack of material testing facilities might strangle the ambitious nuclear power programmes of Europe; today, following cancellations and stretching out, there is probably testing space to spare. The accelerator effect of the mood of 1955 has been reversed in 1959, but by that time the test-reactor projects, undertaken in a rush, were well committed or complete. The surplus space will not be idle. The difference is that under the altered conditions it will not be possible to charge the running costs of test projects against a broad power programme; the funds will come from Government coffers.

Enough Space for New Programme

In the United Kingdom there are four major projects currently under development: the generating boards' power stations, characterised by Magnox canning and large extended surfaces surrounding the fuel; the advanced gas cooled reactor, using uranium oxide and beryllium or stainless steel cans, Project Dragon with carbide or oxide fuel in impermeable graphite sheaths; and the fast reactor scheme which introduces a host of new problems associated with breeding and the use of plutonium. The first three projects are roughly related to each other and some of the experience gained at Calder Hall will be applicable to both the AGR and the HTGCR. In addition, the required irradiation is in a thermal or epithermal flux for all three. The fast reactor, however, stands quite apart; it requires fast flux irradiation, it uses a different coolant, different fuel and different canning materials. The UKAEA have now three large material test reactors in operation to support such a varied programme. All three are of the same type—heavy-water moderated with enriched fuel—the same flux and power rating, and of roughly similar design. Sir John Cockcroft, speaking in Stockholm last October, was of the opinion that these three reactors would provide adequate testing facilities for the Authority's requirements. In addition, there is AEI's Merlin, the design of which was changed from 1 MW to 5 MW in 1955 in response to the Authority's plea for more testing space. Limited material testing programmes can also be undertaken in a number of low-power reactors belonging to the UKAEA or private industry, so that no immediate shortage of testing space and time appears to exist. If anything, there is a slight surplus which could be taken up by a new programme of marine or small reactor construction.

Distinct Surplus in Europe

Britain has jumped the gun on reactor construction and was firmly committed to install 4,000 MW capacity by the time market conditions had changed. In Europe development lagged by a few years and the curious situation arose in which the power programmes could still be cancelled while it was too late to alter the ancillary test programmes. Whereas in the United Kingdom considerable construction followed the investment in research facilities, in Euratom countries there exists, according to Sir John Cockcroft, sufficient test capacity to support a 3,000 MW programme while construction plans are firm for less than 500 MW. Furthermore, stations such as Latina and SENN are supplied complete and require no further development testing by the purchaser. The material testing reactors of Mol, Petten, Ispra and Karlsruhe will find no immediate use in applied research, while Saclay will have to rely on the French domestic programme of construction. In addition, there is the Danish DR-3 reactor becoming critical on 18 January, and Sweden's R2 at Studsvik, which would have been completed in 1959 but for certain difficulties. The Table shows the distribution of testing facilities in Europe and North America, along with the approximate magnitude of the power programme which they are supporting.

Between Two Stools

Having been constructed somewhat prematurely, it is possible that the test reactors will be outdated before the programme for which they were intended materialises. It may be remembered that Canada's NRX had for some time the highest flux available with only $6{\cdot}8 \times 10^{13}$ neutrons per sq. cm per sec., while today test reactors are being considered with fluxes in the order of 10^{15}, and for certain applications the possibility of reaching the 10^{16} range is investigated. There is a twofold reason for higher fluxes. One is the desire to shorten the time required to reach a certain irradiation dose, which is a function of flux. Another, more fundamental reason, is that certain nuclear reactions requiring multiple order capture cannot be studied conveniently at lower fluxes. The production rate of nuclei from multiple neutron capture is a function of the flux raised to the power of the number of captures involved. For example, the production rate of californium 252 from plutonium 239 is proportional to the ninth or tenth power of flux. Similarly, certain experiments in physics using neutron spectroscopy are more conveniently performed at high flux, and it is felt that the two applications alone would justify construction of suitable reactors. The difficulty with Europe's test reactors is that in the flux range for which they were built, there is not enough demand; and for the frontiers of research where they could be usefully employed, there is not enough flux.

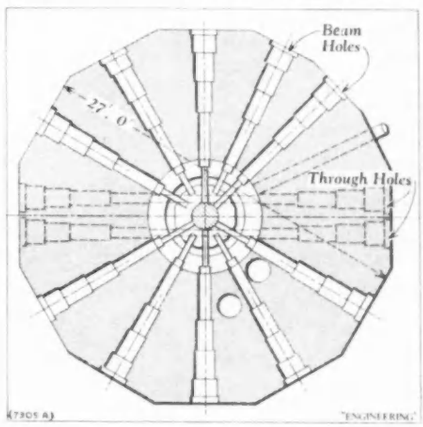
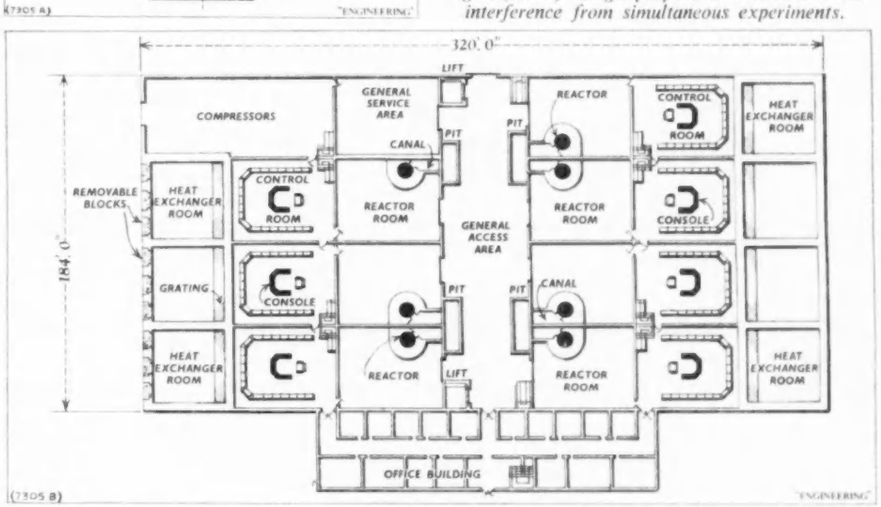


Fig. 1 (left) Typical multi-purpose material testing reactor for twelve simultaneous experiments.

Fig. 2 (below) Single-purpose test reactors avoid interference from simultaneous experiments.



Interference of Experiments

High flux is not the only consideration. There are certain other trends in test reactor design which may affect the future usefulness of the tools available at present. The importance of accurately controlling the flux and temperature levels in irradiation specimens is receiving increased emphasis. As most test reactors are equipped with a number of holes in which several dissimilar experiments are performed simultaneously, the scope of such experiments will be severely limited by the requirements of steady temperature and flux. Removing a specimen and leaving a hole empty, or substituting a different experiment may affect the flux and temperature distribution in other test-holes. As a result, even with the most careful programming, a multi-purpose reactor is a tool of limited flexibility. But the attainment of a high neturon flux invariably involves a very high power level, and hence makes the reactor costly. The desire to make the best use of such a reactor by performing simultaneous experiments is natural, and high-flux test reactors tend to look like a rabbit-warren, so many access holes are provided. Some holes reach inside the core, some only graze the core, and others penetrate only as far as the reflector. Fig. 1 shows a typical multi-purpose test reactor for very high flux, based on a design of Argonne National Laboratory.

Testing Facilities and Power Programmes

	Reactor	Maximum flux	Thermal power	Firm power programme
United Kingdom	Dido, Pluto, DMTR	10^{14}	3 × 10 MW	4,000 MW graphite-gas, fast, HTGCR
	Merlin	5×10^{13}	5 MW	
France	EL-3	10^{14}	15 MW	370 MW graphite-gas, organic
Italy	Ispra	8×10^{13}	5 MW	510 MW
Denmark	DR-3 (Dido)	10^{14}	10 MW	Nil
Sweden	R2	$2{\cdot}4 \times 10^{14}$	30 MW	Deferred
Holland	HFR	$2{\cdot}6 \times 10^{14}$	20 MW	Deferred
Belgium	BR-2	6×10^{14}	25 MW	116 MW
Germany	FR-2	3×10^{13}	12 MW	
	Dido	10^{14}	10 MW	30 MW
	Merlin	5×10^{13}	5 MW	
	Hamburg	$3{\cdot}2 \times 10^{13}$	5 MW	
Canada	NRX	$6{\cdot}8 \times 10^{13}$	30 MW	
	NRU	3×10^{14}	200 MW	220 MW
	Zed-2	—	Low	
United States (maximum flux and approximate total power)	Tank type (19)	7×10^{14}	400 MW	1,200 MW varied designs
	Heavy water (5)	5×10^{14}	70 MW	
	Graphite (2)	5×10^{14}	40 MW	

Special Purpose Test Reactors

An alternative solution (Fig. 2) would be to build single-purpose reactors, one for each experiment. The cost of such an installation would be far less than the cost of a multi-purpose reactor multiplied by the number of units. Only the reactor core and structure and the control equipment needs duplica-

tion; the ancillary equipment such as coolant circulation, heat exchangers, chemical treatment plant, maintenance facilities and radiation control systems could be shared. If only a single beam tube is used per reactor or only vertical sample holes are provided, the floor area is greatly reduced and shielding can be applied in common to a number of units. Because of the cost and high power, it is not practical to build single-purpose reactors for the 10^{16} range of flux. But for lower fluxes single-purpose reactors would perform with far greater efficiency than the individual loops of a multi-purpose reactor. Fig. 2 shows a proposed floor plan for a seven reactor advanced engineering test station (AETR). The design was prepared as an alternative to a single multi-purpose reactor with seven test holes varying from 3 in to 7 in diameter. A single vertical test hole passing through the core, Fig. 3, is used in each case. The length of the test section is 30 in, and the flux variation is limited to 50 per cent of maximum. The arrangement is suitable for cylindrical cores in which the flux-trap technique can be applied to achieve a fairly uniform flux of very high intensity. If the maximum thermal flux is raised to $1{\cdot}5 \times 10^{15}$, the average power of each reactor would be about 140 MW. The aggregate power of the installation would be 1,000 MW, or equal to the total heat output of Berkeley's two reactors.

Diverging Trends in Experimental Techniques

Apart from increasing flux, another feature of recent development has been the steady increase in the size of the irradiation experiments. From the small laboratory samples originally tested in low-power reactors the experiments progressed to the substitution of full scale fuel elements and assemblies, and finally led to the installation of complete test loops. Westinghouse, who are the first manufacturer to produce reactors of a single design in large numbers (25 submarine reactors of the S5W class are on order) have installed facilities for the testing of fully assembled cores. This service has been extended to the Belgian Thermal Reactor being built at Mol, the core of which was brought to criticality before shipment from the United States. In solid-state physics, on the other hand, the size of the experiments has been reduced through the availability of higher flux. The size of samples for neutron diffraction experiments is determined by the requirement for a significant counting rate: with increased flux the same count rate can be obtained from a smaller sample. As the size of available crystals is limited in many cases, each increase in flux broadens the field of application of neutron diffraction techniques.

Coordination

Although Europe's test reactors, becoming critical in quick succession through 1959 and 1960, are modern and up to date, it is possible that too much has been invested prematurely. There is little doubt that nuclear power will come into its own, but perhaps ten to fifteen years hence. In the meantime the heavy investment in test reactors will not be earning the highest returns, and the equipment will be outdated before the power programme—in Professor Rostow's terms—takes off. The unjustified duplication of facilities (there are five DIDO's and 2 MERLINS in Europe) could be avoided by closer cooperation in the planning of test programmes, and by drawing on the resources provided by Euratom-United States and Euratom-Canada coooperation. The liberated European resources could be applied to the creation of facilities suitable for the stream-gauging of future power and research programmes.

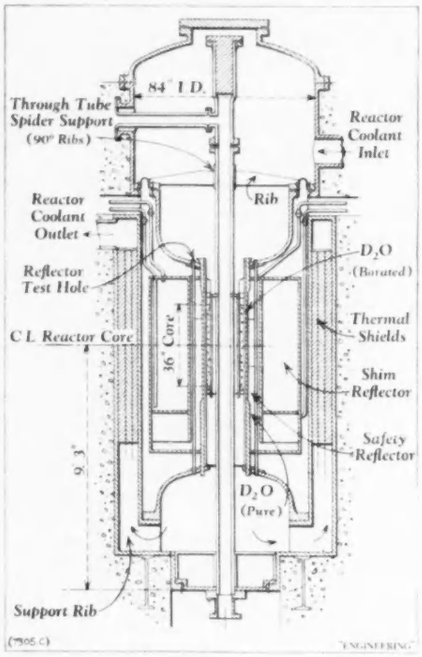


Fig. 3 Cross-section of a single purpose test reactor with vertical through-hole. Flux may be as high as 10^{15}.

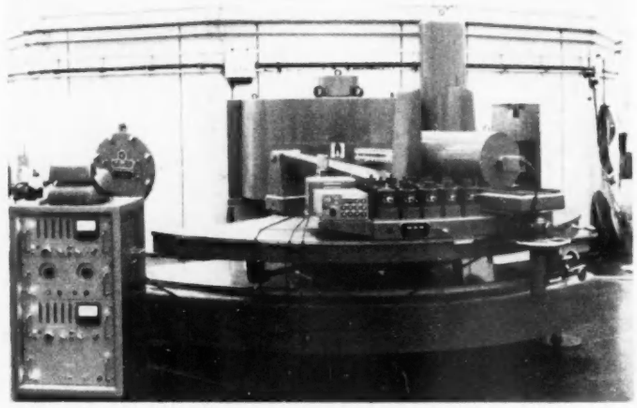


Fig. 4. Neutron diffraction equipment with 130 degree automatic scanning. The scanning cycle may last 30 days.

Notes and News

Danish Materials Testing Reactor Critical

The material testing reactor of the Danish Atomic Energy Commission became critical on 17 January. The reactor is of the PLUTO or DMTR design and was supplied by Head Wrightson and Company. Heavy-water moderated and fuelled with enriched uranium, the reactor is similar in conception to Harwell's DIDO and Australia's HIFAR, although there are differences in shielding and test facilities. Head Wrightson have so far produced six material testing reactors of the DIDO-PLUTO family.

German Programme Reduced to Nil

A sharp peak in a disappointingly flat response to Euratom's invitation for power station projects was that submitted by AKS (Arbeitsgemeinschaft Kernkraftwerk Stuttgart) in collaboration with Interatom (North American Aviation) and Brown Boveri for a 150 MW organic moderated station. At the end of October the documents were ready down to the dotted line—but on 19 January the project was cancelled. Instead of the 500 MW German programme, the US-Euratom collaboration is now left with tentative plans for a West Berlin station, to be submitted by Bewag "as soon as possible." Euratom officials have not hidden their disappointment over the cancellations, and it is indicated that the Federal Government will be approached to effect a reversal.

Belgium Goes Ahead

In contrast, Electricité de France and the Belgian utilities, undecided in October, gave final approval to plans for a 150 MW station at Givet, on the Franco-Belgian border. Of the 1,000 MW US-Euratom programme only 300 MW have been salvaged—by Elettronucleare-Senn and the Franco-Belgian group.

Hunterston Planned to go Critical Late in 1961

Although considerably behind schedule as a result of labour troubles, GEC—Simon Carves expect that the first reactor of the Hunterston power station will be critical late in 1961. On 12 January the first steam raising unit was lifted into position by the 400 ton Goliath crane and is now ready for tubing. The bare shell weighed 325 tons and will receive some 900 tons of heat-exchanger tube and steam drums. The welders' strikes primarily affected the erection of the pressure vessel which is still awaiting placement of the prefabricated bottom cap and bottom grid inside the biological shield.

UKAEA Appointments

New director of industrial power at the UKAEA Development and Engineering Group, Risley, is Mr. Harry Cartwright, formerly deputy director of industrial power.

Appointed as General Manager (Commercial) at the Production Group Headquarters at Risley, Mr. J. B. Laurie will be concerned with contracts for the sale of uranium fuel elements and exchange of engineering information.

Subcritical Assembly for Secondary Schools

Suitable for the training of secondary school students in nuclear physics, Vickers-Armstrongs (Aircraft) have shown a water-moderated subcritical assembly at the Science Masters Exhibition at Southampton University. Vertical aluminium tubes submerged in a tank receive 2½ tons of uranium. The assembly is intended for foil activation and neutron reflection experiments, and the construction is aimed at low cost and safety.

Course in Radiation Protection

A second course in the principles of radiation protection is to be held at the Reactor School, Harwell, from 20 April to 28 June. The course is intended for graduates who work on health and safety problems in the nuclear field. The fee is £250, and closing date for applications is 11 March.

New Fuel Element Laboratory

Irradiated fuel elements will be inspected and processed in the blower houses of No. 2 reactor of the Windscale works, Cumberland, which closed down as a safety measure after the incident in 1957. The laboratory is designed to handle several thousand fuel elements a year from the nuclear power stations as well as from experimental reactors. The facility will permit superficial examination and radiography and provide appratus for sorting out failed elements, decanning, without distortion, dimensional and density measurements and sectioning of the can aneld f urod. A contract for the design and provision of the advanced irradiated fuel element laboratory, with a capital value approaching £1 million, has been awarded to E. G. Irwin and Partners Limited, consulting engineers of London, by the UKAEC. The facility is scheduled to be completed and operating by the end of the year.

Vickers Will Sell Triga Research Reactors

TRIGA research reactors will be manufactured and marketed in the United Kingdom by Vickers Armstrong Limited under licence from General Atomics, division of General Dynamics Corporation. Fourteen Mark I and Mark II TRIGA reactors have so far been sold, eight for export and six within the United States. General Atomics operates the prototype at LaJolla, California. The unique feature of TRIGA—homogeneous zirconium hydride moderated fuel—was reported in Atomic Review on 15 January.

Automatic Neutron Diffraction Facility

Munich's AMF—designed pool reactor is now equipped with an automatic apparatus for the scanning of neutron diffraction experiments in solid state physics. The equipment, manufactured as a standard component for experimental reactors by MAN, Augsburg, is shown in Fig. 4. The apparatus is designed for the automatic scanning of the sample in steps as small as 5 minutes of arc, and the counter will cover a field of 130°. The scanning cycle may be set for a duration of one month. Neutrons are scattered from a crystal sample placed at the axis of a movable shield weighing 2½ tons. The equipment was designed jointly by the Institut fur Technische Physik and MAN.

'Engineering' Appointments Section

PUBLIC APPOINTMENTS

AIR MINISTRY

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and M.T.C.A. Stations. The work of Station Engineer (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineer (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Commencing salary according to age, qualifications and experience. Salary ranges £680 to £850. Candidates must hold O.N.C. Electrical or Mechanical/City and Guilds Electrical Technicians Certificate/2nd Class M.O.T. Certificate, or equivalent, and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering, preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidates with supervisory experience. Opportunities for promotion up to Technical Grade A, maximum salary £1565 (National Rate) and pension prospects. Five-day week, three weeks three days leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applications normally from natural born British subjects only, up to age 55 years. —Write, stating age, qualifications and experience, to MANAGER (P.E.1), PROFESSIONAL AND EXECUTIVE REGISTER, MINISTRY OF LABOUR, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 845

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE require LECTURER in Mechanical Engineering Department to teach Strength of Materials and Theory of Structures up to H.N.C. standard. Graduate or equivalent qualifications, industrial and teaching experience desirable. Burnham F.E. Scale (men) £1370 by £35 to £1550 plus London Allowance. Increments within the scale for approved experience. —Application forms from SECRETARY, AT COLLEGE, WANDSWORTH HIGH STREET, S.W.18, returnable by 10th February. (82) B 171

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—(*a*) Roads, pavements, earthworks and stormwater drainage; (*b*) Foul drainage and sewage disposal; (*c*) Water supply and distribution. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially.

Salary ranges from £680 (at age 25) to £900 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3746) giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 840

UNIVERSITY OF SASKATCHEWAN

SASKATOON, CANADA

Mechanical Engineering—ASSISTANT or ASSOCIATE PROFESSOR for teaching and research in Fluid Dynamics, Gas Dynamics or related field. Advanced degree required. Also, two openings for recent graduates with Master's degrees or equivalent in Mechanical Engineering. Salary schedules among highest in Canada. Interviews will take place in London and particulars should be sent to THE AGENT GENERAL FOR SASKATCHEWAN, 19, CHESTER MEWS, LONDON, S.W.1. B 155

LONDON COUNTY COUNCIL

ROBERT BLAIR FELLOWSHIP IN

APPLIED SCIENCE AND TECHNOLOGY

Applications are invited for the award of the Robert Blair Fellowship tenable for one year of advanced study or research abroad in applied science and technology. The value of the award is subject to variation, and, if the country selected should be Canada or the U.S.A., may be up to £2000 (subject to income tax).

Candidates must be British subjects and at least 21 years of age.

Further particulars and forms of application may be obtained from the EDUCATION OFFICER (ED/MA/14), THE COUNTY HALL, S.E.1 (stamped addressed foolscap envelopes necessary) for return by 12th March, 1960. (75) B 109

WELSH COLLEGE OF ADVANCED

TECHNOLOGY

CATHAYS PARK, CARDIFF

ELECTRICAL ENGINEERING

Applications are invited for the following posts:—(*a*) SENIOR LECTURER. (*b*) LECTURER.

Salary—Senior Lecturer: £1550 by £50 to £1750. Lecturer: £1370 by £35 to £1550.

Teaching duties will be mainly in Diploma in Technology courses; research and consulting work is encouraged.

MECHANICAL ENGINEERING

Applications are invited for the following posts:—(*a*) READER. (*b*) SENIOR LECTURER.

Salary—Reader: £1800 by £50 to £2100. Senior Lecturer: £1550 by £50 to £1750.

For post (*a*) the candidate appointed will have as primary responsibility the initiation and supervision of research work.

For post (*b*) applicants should be University graduates in Mechanical Engineering and have had adequate industrial experience.

Forms of application, together with further particulars, may be obtained from the PRINCIPAL AT THE COLLEGE, and should be returned as soon as possible.

ROBERT E. PRESSWOOD,
Clerk to the Governors.

CITY HALL,
CARDIFF. B 165

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON and PROVINCES ENGINEERING DESIGNER DRAUGHTSMEN experienced in preparation of pipework and mechanical and electrical plant layouts. Candidates should have served recognised apprenticeship or had equivalent training and also have had practical experience. O.N.C. an advantage. Financial assistance and time off given for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially. Overseas tours for which special allowances granted.

Salary in LONDON ranges from £680 (at age 25) to £900 p.a. for men; from £673 to £868 p.a. for women. Somewhat lower in PROVINCES. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c., LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3743), giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 846

IMPERIAL SMELTING
U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

The following engineering vacancies are currently available at the Avonmouth Works and in Group Departments on the Avonmouth Site:—

AVONMOUTH WORKS

Assistant Area Engineer

Duties involve controlling work done by tradesmen and labourers on zinc blast furnace and associated plant, including provision of spares, operation of bonus schemes, and general supervision of engineering maintenance work. An apprenticeship, preferably in heavy engineering, and professional qualification or degree in Mechanical Engineering essential. Previous experience in a supervisory capacity in heavy chemical or metallurgical industry is desirable. Age limits 23-35. Ref. EG/ENG/70.

CHIEF ENGINEER

Engineering Assistants

Opportunities to train for future engineering posts of responsibility exist for two young men with a university degree or Higher National Certificate in Mechanical or Chemical Engineering. Mobility is important since the persons appointed may be required to work for indefinite periods at any of the seven Works Sites. Ref. EG/ENG/71.

Group Mechanical Engineer

One of a team of design engineers who are collectively responsible for the detail design work arising out of capital expenditure projects at any of the Corporation's Works and for following the projects through to their completion, including procurement and construction. A university degree or professional qualifications in Mechanical Engineering will be required, together with sound design experience, preferably in heavy engineering. Ref. EG/ENG/72.

Draughtsmen

For the development of schemes and detailing of equipment to guide invitations to tender and the manufacture of plant. At least five years' experience, preferably in heavy engineering, is required and preference will be given to candidates holding N.C. or H.N.C. in Mechanical Engineering. Ref. EG/ENG/73.

IMPERIAL SMELTING PROCESSES LIMITED

Design Engineer

A qualified engineer, preferably with a first class honours degree and sound experience, including design in the heavier type of engineering, is sought. Duties are to participate in the design and development of blast furnaces and ancillary plant for the Imperial Smelting Process and in this instance fluency in both written and spoken German is very desirable. Ref. EG/ENG/74.

Applications, quoting the reference(s) of particular interest and giving brief details of qualifications and experience, should be addressed to:—

Personnel Manager,
IMPERIAL SMELTING CORPORATION LTD.
St. Andrew's Road, Avonmouth, Bristol.

B 154

BRITISH TRANSPORT DOCKS

invite applications for

ENGINEERING ASSISTANT

in the Dock Engineer's Office, Grimsby Docks.

Candidates should have experience in design, construction and maintenance of civil engineering works and preparation of cost estimates, contract drawings and documents. Associate Membership of one of the Engineering Institutions desirable. Salary range £1045-£1150 per annum. Contributory Superannuation Scheme and certain rail travel facilities.

Applications, stating age, education, training, experience and qualifications, to be sent to:—

STAFF AND ESTABLISHMENT OFFICER,
BRITISH TRANSPORT DOCKS (E),
163, EUSTON ROAD, LONDON, N.W.1,

to arrive not later than Monday, 8th February, 1960. B 163

TECHNICAL MANAGER

Required for old-established and progressive engineering firm of medium size known the world over.

Products cover high-quality medium-heavy to light mechanical and hydraulic machinery in small batches for a great variety of industrial applications both in production and research.

An intensive development programme is followed which must be maintained and augmented with suitable instrumentation of mechanical, electrical and electronic kinds.

Qualifications include thorough technical knowledge and practical experience of engineering, and ability both to control design staff and to foster the whole of the Firm's technical activities from a broad and progressive angle.

Fullest particulars should be given of academic qualifications, practical experience, posts held, type of work handled, and of contacts with industry and research establishments.

Write, stating age, present earnings and when available, to:—

The Managing Director,
SAML. DENISON & SON LIMITED,
HUNSLET FOUNDRY,
LEEDS, 10.

B 133

DESIGNER DRAUGHTSMEN

- SENIOR STRUCTURAL (STEEL)
- ARCHITECTURAL
- ELECTRICAL

Designer/Draughtsmen of the above categories are cordially invited to contact us with a view to permanent employment. Candidates must hold Higher National Certificate or equivalent plus five to seven years' design experience. Successful applicants will benefit from excellent salaries, first class working conditions, attractive personal benefits and every opportunity for promotion. Apply Personnel Manager.

KELLOGG INTERNATIONAL CORPORATION

7-10, CHANDOS STREET, LONDON, W.1. TEL. MUSEUM 4010

Quoting reference 158/H

B178

a number of DESIGN ENGINEERS

are required, with experience in the design and the associated calculations of Condensing, Feed Heating and De-aerating Plants for Land Service Power Stations.

Applicants should have a University Degree or equivalent qualification, with specialised experience in Heat Transfer.

Salaries offered will be appropriate to experience and responsibility, and there is a contributory Pension and Life Assurance Scheme in operation.

Barrow in Furness is pleasantly situated on the coast adjacent to the Lake District. The Company has a well-appointed Sports Club and Grounds, with comprehensive recreational facilities both social and sporting. An illustrated guide to the town and surroundings can be sent on request.

All applications should be addressed to the

ENGINEERING TECHNICAL MANAGER,

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED,

Naval Construction Works, Barrow in Furness, Lancashire. B134

draughtsmen

To meet an expanding programme of development,

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PLASTICS DIVISION

urgently need more Draughtsmen. In particular, men are required experienced in work associated with process plant, e.g., piping, heating and ventilating, drying, powder conveying and packing. Mechanical draughtsmen are also needed since the programme includes development work in novel processes which are essentially mechanical in nature. There are vacancies too for men with instrument and electrical design experience.

Good starting salaries will be paid and pension and profit sharing schemes are in operation. For married men temporary lodging allowances are available and assistance is given towards house purchase and removal expenses.

Apply briefly to the Staff Manager,

IMPERIAL CHEMICAL INDUSTRIES LIMITED
PLASTICS DIVISION
BLACK FAN ROAD, WELWYN GARDEN CITY, HERTS.

A 939

COUNTY BOROUGH OF BOLTON
EDUCATION COMMITTEE
BOLTON TECHNICAL TRAINING COLLEGE

Director: J. P. PARRY, M.A.

Required for May, 1960, two Senior Lecturers as follows:—

(1) SENIOR LECTURER qualified in Mechanical Engineering.

(2) SENIOR LECTURER qualified in Mining.

Salary: Senior Lecturer, £1370 by £35 to £1600.

(1) Senior Lecturer qualified in Mechanical Engineering, to specialise in methods of teaching mechanical engineering subjects and to assist with the general training programme of the College.

A University Degree, Associate membership of the Institution of Mechanical Engineers, successful extensive teaching experience and industrial experience are all highly appropriate qualifications.

(2) Senior Lecturer in Mining, to specialise in methods of teaching mining subjects and to assist with the general training programme of the College.

Desirable qualifications for the post are a University Degree or Associate membership of the Institute of Mining and First Class Mine Managers Certificate, together with good practical experience in the mining industry and successful extensive teaching experience.

Further information and application forms may be obtained from the CHIEF EDUCATION OFFICER, NELSON SQUARE, BOLTON, to whom completed applications should be returned not later than 12th February, 1960.

W. T. SELLEY,
Chief Education Officer B 167

UNIVERSITY OF NOTTINGHAM
I.C.I. RESEARCH FELLOWSHIPS

Applications are invited for IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS in Chemistry (including Agricultural Chemistry), Physics, Pharmacy, Engineering, Metallurgy and related subjects, tenable at the University of Nottingham. A number of appointments may be made as from 1st October, 1960, with a normal tenure of three years. The salary will be within the scale £700-£1000 per annum depending on qualifications and experience. Fellows will have status as members of the academic staff and will be eligible for F.S.S.U. benefits and children's allowances.

Further particulars and forms of application may be obtained from the REGISTRAR, to whom applications must be returned not later than 31st March, 1960. B 166

(*a*) EXPERIMENTAL OFFICERS
(*b*) ASSISTANT EXPERIMENTAL OFFICERS

Pensionable posts for men and women in Mathematics, Physics, Meteorology, Chemistry, Metallurgy, Biological Sciences, Engineering, Miscellaneous (Geology, Library and Technical Information Services). Candidates must, on 31.12.60, be at least 26 and normally under 31 for (*a*), and at least 18 and normally under 28 for (*b*). Qualifications should normally include H.S.C. or G.C.E., or equivalent, or H.N.C. or University degree. Provisional admission if taking examinations in 1960. Men's salary scale (London): (*a*) £1095-£1233; (*b*) £397 10s. (at 18)-£710 (26 or over), rising to £880. Promotion prospects. Further education facilities. —Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S94-95/60. B 170

UNIVERSITY OF BELFAST

The Senate of The Queen's University of Belfast invites applications for THREE LECTURESHIPS in Mechanical Engineering from 1st October, 1960, or earlier. Preference will be given to candidates who are interested in Mechanical Vibrations and Servomechanisms or Thermodynamics and Fluid Mechanics or Strength of Materials and Metallurgy. Salary range £900 to £1650 plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience.—Applications should be received by 15th March, 1960. Further particulars may be obtained from G. R. COWIE, M.A., LL.B., J.P., SECRETARY. B 175

UNIVERSITY OF SYDNEY
DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for the following positions in the Department of Civil Engineering:—

(1) SENIOR LECTURESHIP in Civil Engineering.
Candidates should have had research and teaching experience in Strength of Materials.

(2) LECTURESHIP/SENIOR LECTURESHIP in Civil Engineering.
The successful applicant will be required to teach and engage in research in Hydraulics.

The salary for a Senior Lecturer is within the range £A2200 by £A80 to £A2600 per annum; for a Lecturer within the range £A1500 by £A90 to £A2100 per annum. In each case cost of living adjustments will be allowed (at present £A23 p.a.). The salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 GORDON SQUARE, LONDON, W.C.1.

Applications close, in Australia and London, on 12th March, 1960. B 175

SENIOR DRAUGHTSMAN

SENIOR DRAUGHTSMAN required by NORTH THAMES GAS BOARD at MONCK STREET, WESTMINSTER, S.W.1, for the design and detailing of reinforced concrete structures and foundations associated with gas works.

Candidates should possess the Higher National Certificate as a minimum qualification. Commencing salary will be within the range £763 to £962 per annum according to qualifications and experience.

The appointment will be of a permanent nature, and the successful candidate will be required to join the Board's staff contributory pension scheme.

Applications, stating age, qualifications and experience, should be sent within ten days of the appearance of this advertisement, to the STAFF CONTROLLER, NORTH THAMES GAS BOARD, KENSINGTON CHURCH STREET, W.8, quoting reference EG/767. B 143

ROYAL AIRCRAFT ESTABLISHMENT
TECHNICAL COLLEGE
FARNBOROUGH, HANTS

Applications invited for post of SENIOR LECTURER IN AIRCRAFT STRUCTURES to teach subject for Final B.Sc.(Eng.), Dip.Tech. and A.F.R.Ae.S.

University degree, or equivalent, and preferably some industrial and/or teaching experience required. Facilities for research available. Duties to commence as soon as possible.

Burnham Scale for Technical Colleges: £1550 by £50 to £1750.

Details and application forms from PRINCIPAL OF COLLEGE for return within fourteen days. B 137

THE UNIVERSITY OF LIVERPOOL

Applications are invited for THREE LEVERHULME POSTGRADUATE FELLOWSHIPS, two in the Faculty of Science and one in the Faculty of Engineering, tenable for one year at the value of £600, and renewable for a second year.

Applications, three copies, stating age, details of qualifications and experience, publications, research work in progress and completed, and an outline of the proposed field of research, together with the names of two referees, quoting Ref. CV/En, should be received not later than 1st March, 1960, by the REGISTRAR, from whom further particulars may be obtained. B 132

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the following post in the Department of Mechanical Engineering:—

(*a*) LECTURER. The initial salary will be within the range £900-£1500 per annum according to age, qualifications and experience.

(*b*) TEMPORARY SENIOR LECTURER OR LECTURER. The appointment will be for a period of twelve months from 1st October, 1960. The salary will be within the range £900-£1700 according to age, qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, Ref. CV/En, should be received not later than 22nd February, 1960, by the REGISTRAR, from whom further particulars of the conditions of appointment may be obtained. B 131

COVENTRY TECHNICAL COLLEGE

Principal Designate: H. C. SMITH, M.Sc., Ph.D., F.R.I.C.

Applications are invited for the following full-time posts, duties to commence 1st May, 1960:—

BROOKLANDS ANNEXE

ASSISTANT LECTURER GRADE A to teach Mathematics to students in the age range 16-18, mainly for Preliminary Engineering and General Education courses. Some teaching experience desirable.

*Salary (men), £520 by £27 10s.-£1000 per annum plus additions for approved study and training.

MATHEMATICS DEPARTMENT

ASSISTANT LECTURER GRADE B to teach Mathematics up to Ordinary National Certificate standard. Candidates should be graduates of a British University. Engineering experience, together with some teaching experience, an advantage.

*Salary (men), £700 by £27 10s.-£1150 per annum plus training and graduate allowances which may reach £285 per annum.

*Starting salary depends on age and experience. Women receive slightly less at present but equal pay will apply by 1961.

Application forms and further particulars on receipt of stamped addressed foolscap envelope, from the PRINCIPAL, COVENTRY TECHNICAL COLLEGE, BUTTS, COVENTRY, to whom completed applications should be submitted by 12th February, 1960.

W. L. CHINN,
Director of Education. B 190

CITY OF NOTTINGHAM
WATER DEPARTMENT
APPOINTMENT OF CIVIL ENGINEERING ASSISTANT

Applications for the above permanent, pensionable appointment are invited from Graduate Members of the Institution of Civil Engineers or from University Graduates who have had five years' engineering experience (including the period spent on theoretical training). Salary, dependent upon qualifications and experience, in the special grade for Engineering Assistants (£785 by £40's (6) by £45 to £1070).

Applications, with names of two persons to whom reference may be made, to ENGINEER AND GENERAL MANAGER, WATER DEPARTMENT, CASTLE BOULEVARD, NOTTINGHAM, not later than the 12th February, 1960.

T. J. OWEN,
Town Clerk B 188

A career with scope at SMITHS

We are leaders in the design, development and manufacture of Motor Accessories and as such offer excellent prospects to men with the desire to progress within a large and expanding organisation.

OPPORTUNITIES EXIST AT CRICKLEWOOD FOR:—

SENIOR DRAWING OFFICE CHECKER

The man appointed will be responsible for checking drawings prior to large scale production.

Experience in this type of work is essential, preferably in the light precision engineering field. H.N.C. standard or equivalent qualification essential.

DEVELOPMENT ENGINEER

This interesting and responsible post occurs in the Product Development Department, and is available to men who have had at least the past five years' continuous experience in the development of precision mechanisms for mass production. An H.N.C. in Mechanical Engineering would be a suitable qualification, although A.M.I.Mech.E. would be preferred. An apprenticeship or equivalent practical training is essential.

DESIGNERS

We require men with new ideas and a natural urge to Design in the ever-widening and exciting field of mass-produced instruments and light mechanisms.

Suitable persons will have been engaged in design work continuously for at least the past five years in the light precision engineering industry.

An apprenticeship or equivalent is necessary, together with the essential qualification of H.N.C.

SENIOR DRAUGHTSMEN

Senior Engineering Draughtsmen with experience of small mechanisms for mass production required in the production offices. Suitable applicants must be qualified to at least H.N.C. standard. A knowledge of press work would be an advantage.

These are Senior Posts carrying attractive salaries and monthly staff status.

PROVING ENGINEERS

This post is open to men having experience with electrical instruments, mechanical instruments and associated equipment. Suitable candidates would be between 25-30 years of age and be qualified to at least O.N.C. standard.

APPLICATIONS WILL BE TREATED IN STRICT CONFIDENCE *EVENING INTERVIEWS CAN BE ARRANGED ON REQUEST*

Write to the Staff Manager, quoting reference SM.238

S. SMITH & SONS (ENGLAND) LTD., CRICKLEWOOD, N.W.2.

B179

LANCHESTER COLLEGE OF TECHNOLOGY COVENTRY

Principal: A. J. RICHMOND, B.Sc.(Eng.)(Lond.), Ph.D., M.I.Mech.E.

Applications are invited for the following posts to complete the initial staffing of this new College which will commence to function from the Summer of 1960. The College will offer advanced Sandwich and full-time courses, H.N.C. and certain more advanced City and Guilds courses, as well as a range of professional courses in Commerce and Management Studies.

For all posts duties to commence from dates to be arranged but not later than 1st September, 1960.

DEPARTMENT OF MECHANICAL ENGINEERING

ONE PRINCIPAL LECTURER who will rank as Deputy Head of Department.

ONE SENIOR LECTURER able to teach Mechanics of Fluids and Theory of Machines; subsidiary Theory of Structures an advantage.

Candidates should be University graduates and chartered Mechanical Engineers.

DEPARTMENT OF PRODUCTION ENGINEERING

THREE LECTURERS able to teach one or more of the following Metrology and Inspection, Machine Tool Design and Application, Production Tooling and Design.

Candidates should be corporate members of the Institution of Production Engineers and preferably at least graduate members of the Institution of Mechanical Engineers.

DEPARTMENT OF AERONAUTICAL ENGINEERING

ONE LECTURER, able to teach Aero. Design and Structures.

Candidates should be University graduates and Associate Fellows of the R.Ae.S. (or be qualified to join the Society).

DEPARTMENT OF ELECTRICAL ENGINEERING

THREE SENIOR LECTURERS: one specialising in Electrical Power (including generation), Distribution and Utilisation; one specialising in Control Systems and related subjects; one specialising in Digital Circuit and Pulse Techniques.

Candidates should be University graduates and chartered electrical engineers.

Appropriate Industrial or Commercial or Research experience essential for all posts.

SALARIES (MEN)

Principal Lecturer, £1750 by £50 to £1900 p.a.

Senior Lecturers, £1550 by £50 to £1750 p.a.

Lecturers, £1370 by £35(4) and £40(1) to £1550 p.a.

In certain circumstances candidates may be paid a commencing salary above the minimum of the respective scales.

Women receive slightly less at present but equal pay will apply from April, 1961.

Further particulars and application forms (stating the posts or post concerned) from the REGISTRAR, LANCHESTER COLLEGE OF TECHNOLOGY, temporary address: BUTTS, COVENTRY, to whom completed forms should be returned by 25th February, 1960.

W. L. CHINN,
Director of Education. B 191

UNIVERSITY OF ST. ANDREWS

Applications are invited for a LECTURESHIP in Electrical Engineering in Queen's College, Dundee. Good honours degree in Electrical Engineering or Physics; suitable experience in light-current Electrical Engineering and Applied Electronics. Salary scale, £900 by £50 to £1350 (efficiency bar) by £75 to £1650; placing according to qualifications and experience; F.S.S.U.; Family Allowance; grant towards removal expenses. Further particulars from the undernoted to whom applications (six copies), containing the names of three referees, should be sent not later than 27th February, 1960.

PATRICK CUMMING,
Joint Clerk to the University Court,
Queen's College, Dundee. B 193

BOROUGH POLYTECHNIC BOROUGH ROAD, S.E.1

Principal: JAMES E. GARSIDE, M.Sc.(Tech.), Ph.D., F.R.I.C., F.I.M., F.Inst.F.

The Governors invite applications for the following appointments:

DEPARTMENT OF MECHANICAL ENGINEERING

Head of Department: G. L. H. BIRD, B.Sc.(Eng.), M.I.Mech.E., M.Inst.R.

TWO LECTURERS IN MECHANICAL ENGINEERING

POST 1—Candidates should have specialised knowledge and experience to teach advanced production engineering with special reference to deformation processes.

POST 2—Candidates should have specialised knowledge and experience in Heat Transfer theory and Engineering Thermodynamics and their applications.

For both appointments candidates should be University Graduates in Mechanical Engineering and have had responsible industrial and/or research experience. For post 1 post-graduate qualifications in some aspect of Production Engineering would be an added qualification. For both appointments there are excellent opportunities for research.

ASSISTANT LECTURER (GRADE B) IN MECHANICAL ENGINEERING

Candidates should be University Graduates in Mechanical Engineering and have had appropriate industrial experience. Duties include teaching Engineering Science and Engineering Drawing and Design to National Certificate standard and above. Opportunities will be given for participation in teaching in advanced "Sandwich" courses and in research.

Whilst it is desired to fill the above posts by 1st May, 1960, applications will be entertained from candidates unable to take up an appointment before 1st September, 1960.

Further particulars and Application Form, which should be returned as soon as possible, obtainable from the undersigned.

FREDK. J. PACKER,
Clerk to the Governing Body. B 181

JOSEPH LUCAS (ELECTRICAL) LIMITED

There are vacancies for

DESIGNERS & DRAUGHTSMEN FOR LIGHTING DEPARTMENT

to work on mechanical design of a wide range of lamps for new car models. The work involves the application of pressure diecasting, pressing and plastic moulding techniques for large quantity production and some experience in one of these fields would be an advantage.

Applicants should have higher National Certificate, but consideration will be given to man with Ordinary National Certificate and suitable experience. The posts are permanent and pensionable, and a good starting salary will be paid. Five-day week.

Apply in writing, stating age, qualifications and experience, to the PERSONNEL MANAGER,

JOSEPH LUCAS (ELECTRICAL) LIMITED,
Great King Street, Birmingham, 19, quoting reference PM/D/373. B 162

SENIOR MECHANICAL/ELECTRICAL ENGINEER

post leads to senior in charge group M/E engineers and design staff engaged on industrial and other projects covering mechanical, electrical and general services. Wide all-round experience essential; professional qualifications necessary; experience on consulting side advantageous. Age to 40-45. Remuneration will be based on qualifications and experience as well as responsibilities of post.

Applications to

SENIOR PARTNER (CONFIDENTIAL),
SIR ALEXANDER GIBB & PARTNERS,
QUEEN ANNE'S LODGE,
WESTMINSTER, LONDON, S.W.1,

should detail career. B 141

SHELL

THE ROYAL DUTCH/SHELL GROUP

require

CHEMICAL ENGINEERS

IN HOLLAND

for

DESIGN, DEVELOPMENT TECHNOLOGICAL AND OPERATIONAL WORK

Applicants should possess an Honours Degree in Chemical Engineering or the equivalent professional qualification, with at least five years' relevant experience.

The upper age limit is 35 years.

Applications with full details to:

SHELL INTERNATIONAL CHEMICAL COMPANY LIMITED,

Personnel Recruitment/HI,

St. Helen's Court, Gt. St. Helen's, London, E.C.3.

B 153

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

BURTON STREET, NOTTINGHAM

Principal: D. A. R. CLARK, M.Sc.(Tech.), M.I.Mech.E.

Applications are invited for the following full-time RESEARCH ASSOCIATESHIP, Mechanical Engineering Department. This research post offers considerable scope. Applicants should possess an engineering degree of a British University, and the person appointed will be encouraged to prepare for a higher degree if appropriate.

The salary for the above post is as follows: £650 by £50 to £750 per annum.

Further particulars and form of application may be obtained from the PRINCIPAL, to whom completed forms should be returned not later than 20th February, 1960. B 187

UNIVERSITY COLLEGE OF THE WEST INDIES

Applications are invited for the CHAIR OF CIVIL OR MECHANICAL ENGINEERING. Applicants should possess broad interests within the whole field of Engineering education and be interested in the detailed design and equipment of laboratories for a new Faculty. Salary £2500 p.a. Child allowance. F.S.S.U. Unfurnished accommodation 5 per cent. basic salary. Passages for up to 5 persons on appointment, normal termination and study leave (once every three years).

Detailed applications (6 copies) naming 3 referees by 28 February, 1960, to SECRETARY, INTER-UNIVERSITY COUNCIL FOR HIGHER EDUCATION OVERSEAS, 29 WOBURN SQUARE, LONDON, W.C.1, from whom further particulars may be obtained. B 185

APPOINTMENTS OPEN

YOUNG ENGINEER

YOUNG ENGINEER required as Boiler Sales representative for London Office. Training will be given in the Lincoln Works before taking up the London post. Age about 30. Experience on boilers or combustion equipment essential; adaptable, enthusiastic. Salary will reflect experience and knowledge and there is a generous pension scheme.—Apply STAFF MANAGER, RUSTON & HORNSBY LTD., WATERSIDE SOUTH, LINCOLN. B 146

THE MANCHESTER SHIP CANAL COMPANY

The Manchester Ship Canal Company invite applications for the appointment of ASSISTANT CIVIL ENGINEERS AND DESIGN ENGINEERS on the established staff of the Chief Engineer. Scale of salaries: £805 at age 25, rising by annual increments to £1250 at 38 with prospects of promotion to higher grades at salaries up to £1720.

Candidates should be Corporate Members of the Institution of Civil Engineers or hold equivalent qualifications, and should have experience in design, specifications, construction and maintenance of Civil Engineering works. Harbour and dock experience is preferable but not essential.

Successful applicants will require to become members of the Company's Contributory Superannuation Scheme.

Applications, stating age, qualifications and experience, should be addressed to the Chief Engineer, THE MANCHESTER SHIP CANAL COMPANY, SHIP CANAL HOUSE, KING STREET, MANCHESTER, 2, not later than 13th February, 1960. B 90

HEAT TRANSFER ENGINEER

HEAT TRANSFER ENGINEER. A.M.I.Mech.E. or H.N.C., for work on Extended Surface and Plain Tube Heat Exchangers Factory in West Sussex. Prospects excellent in rapidly developing company. Must be willing to travel.—BOX B 119 Offices of ENGINEERING.

RESEARCH AND DEVELOPMENT ENGINEER

required
for work on the
COMBUSTION OF LIQUID FUELS

This position offers the successful candidate outstanding opportunities to carry out work, from fundamental research to commercial development, in the field of oil burning, in the newly formed Research Department of one of the pioneer companies of this Industry.

Applicants should have a degree in Mechanical Engineering or equivalent qualifications. Experience either in combustion or aerodynamics is desirable but consideration will be given to candidates without this experience who are otherwise suitable.

The Company operates a contributory superannuation fund and a life assurance scheme.

Applications which will be treated in strict confidence, should include details of age, education, experience and salary required, and be addressed to BOX B 107, Offices of ENGINEERING.

JOSEPH LUCAS (ELECTRICAL) LIMITED

MECHANICAL ENGINEERS

There are vacancies in our laboratories for

SENIOR TECHNICAL ASSISTANTS

to work on a wide range of investigations associated with the performance of internal combustion engines including starting at low temperatures. Applicants should have had previous engine experience, preferably including engine testing and be of Ordinary National Certificate standard.

The posts are permanent and pensionable. Five-day week.

Apply in writing, stating age, qualifications and experience, to the PERSONNEL MANAGER,

JOSEPH LUCAS (ELECTRICAL) LIMITED,

Great King Street, Birmingham, 19, quoting reference PM/D/371. B 161

BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION

Applications are invited for appointments to the

DEVELOPMENT STAFF

and to the

BRIDGE DEPARTMENT

Candidates should be young men with some experience in the design and detailing of steel frame buildings with knowledge of B.S.449 or with experience in the design of steel bridges with knowledge of B.S.153. Five-day week and luncheon vouchers. Admission to non-contributory pension scheme after qualifying period.

Apply in confidence to the TECHNICAL ADVISER, BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION, ARTILLERY HOUSE, ARTILLERY ROW, LONDON, S.W.1, giving fullest details with salary required. B 174

GEORGE WIMPEY & CO., LIMITED

invite applications from

STEELWORK DESIGNER DETAILERS

STEELWORK DETAILERS

REINFORCED CONCRETE DESIGNER DETAILERS

REINFORCED CONCRETE DETAILERS

Rapid expansion of our Head Office organisation offers first-class opportunities for keen and experienced men in the field of Chemical and Refinery structures.

These appointments carry attractive salaries; personnel benefits include opportunity to join pension scheme, and full restaurant facilities.

Apply, giving full details of experience to:—

R. E. J. Worth, M.I.C.E.,

PLANNING DEPARTMENT, 27, HAMMERSMITH GROVE, LONDON, W.6 B 157

PROCESS PIPING SYSTEM ENGINEERS

Chemical or Mechanical Engineers are required for work on the design of process and utility piping systems for oil refinery and petro-chemical plants. The work involves the preparation of engineering flow diagrams and close liaison with our Process, Instrument, Mechanical Equipment, Plant Layout and Operating groups.

Applicants should have a University Degree in either Chemical or Mechanical Engineering and also at least two years' relevant post-graduate experience in industry.

Above average salaries will be paid to men with the required qualifications. Comprehensive personnel benefits include contributory Pension Scheme, Luncheon Vouchers, excellent working conditions, Social Club, etc. When overtime is worked, payment is made for hours involved.

Please apply by letter to Personnel Manager

KELLOGG INTERNATIONAL CORPORATION

7-10, CHANDOS STREET · CAVENDISH SQUARE · LONDON, W. 1. · QUOTING REFERENCE H/157

B 177

AN OPPORTUNITY FOR FIRST CLASS ENGINEERS

AN OPPORTUNITY FOR FIRST CLASS ENGINEERS EXPERIENCED IN MECHANISATION AND AUTOMATION. The Plessey Organisation, which covers a wide range of products and operates in Essex, Wiltshire, Hampshire and Northants, is anxious to expand its force of Mechanisation Engineers.

The concept calls for forward thinking and lively men who have a sound engineering background. Ideally, candidates should have served an engineering apprenticeship, have had design experience and show evidence of above average progress in the production engineering field in the light/medium mechanical engineering industry. Professional qualifications are desirable for the senior posts but vacancies also exist for men with outstanding practical experience but no formal qualifications. Moreover, the scheme offers excellent future opportunities to young men who join the Company now as Planning and Methods Engineers. Applications are particularly welcome from Engineers who have specialised and can show evidence of success in the application of automation principles. The rapid expansion of the Plessey Company in all its fields, offers a great challenge to men with ambition from junior to the most senior levels.

Interviews will be arranged in London and the provinces as necessary and applications stating age, experience and qualifications should be sent, in confidence, to A. M. BROWN, EXECUTIVE DIRECTOR (PERSONNEL), THE PLESSEY COMPANY LIMITED, ILFORD, ESSEX, quoting DHA/11K. B 130

CHIEF ELECTRICAL DRAUGHTSMAN

If you are a graduate member of the Institution of Electrical Engineers and have good drawing office experience, and would like to join the Commonwealth's largest glass manufacturing organisation, you are invited to write about yourself to the WORKS PERSONNEL OFFICER, COWLEY HILL WORKS, PILKINGTON BROTHERS LIMITED, ST. HELENS, LANCASHIRE, quoting reference CED/K. You would be in charge of an electrical drawing office and would be responsible to the works electrical engineer for preparation of specifications, drawings and estimates for HV and MV electrical distribution schemes, illumination and equipment for industrial plant and buildings for a works with maximum demand of 15,000 kVA. B 140

CIVIL AND MECHANICAL ENGINEERS

A. BOAKE, ROBERTS & CO., LTD., require for their Design Office:—

(1) A QUALIFIED MECHANICAL ENGINEER. Age not less than 30, preferably A.M.I.Mech.E., with some years' experience in the chemical (or allied) industry.

(2) QUALIFIED CIVIL ENGINEER. Preferably A.M.I.C.E. with experience in industrial building design.

Both the above appointments are permanent and pensionable. Salary scales are on an age and qualification basis.—Applications should be addressed to the PERSONNEL MANAGER, 100 CARPENTERS ROAD, LONDON, E.15. B 144

TECHNICAL ENGINEERING WRITER

(age 28-35 years)

is required by a large firm of component manufacturers in the Midlands dealing with the Automobile, Aircraft and General Engineering Industries. Must be a qualified engineer with journalistic experience, capable of producing technical descriptions of products and installations from information acquired from Drawing and Design Offices.

Applications in writing stating age, experience, qualifications and salary, to BOX B 158, Offices of ENGINEERING.

Our Staff have already been notified of this vacancy.

QUALIFIED ELECTRICAL ENGINEER

A vacancy exists for a qualified electrical engineer with an Hydro-Electric Power undertaking in Northern Nigeria. Pleasant climate 4,000 ft. above sea level. Age 30 to 35. Salary grade £1335/1565 according to age, qualification and experience. Pension and Life Assurance Scheme. Eighteen months tours with three months' leave on full salary. Free furnished quarters. Free passages self, wife and two children, or equivalent benefits if children remain at home.—Write BOX D401, c/o STREET'S, 110, OLD BROAD STREET, E.C.2. B 86

Experienced Graduate Engineers

are required by

the manufacturers of the widest range of plastics raw materials and semi-finished products in the Commonwealth.

The Plastics Division of Imperial Chemical Industries Limited is now expanding its Engineering Department in order to keep pace with growing sales in home and overseas markets. Enquiries are invited from:—

Mechanical and Chemical Engineers

holding first or second class honours degrees with some years of industrial experience.

The Division is looking for men of energy, initiative and proved ability. Good starting salaries will be paid immediately, and prospects for the future are excellent. The individual projects upon which candidates will be engaged vary in character and involve all types of engineering, from light precision machine work to heavy process. They include all the planning, layout and procurement associated with the design and erection of large manufacturing units. Some of the work is experimental, directed towards manufacture in new fields.

Conditions of service are good and pension and profit-sharing schemes are in operation. For married men, temporary lodging allowances are available and assistance is given towards house purchase and removal expenses.

Apply briefly to:—

The Staff Manager,
Imperial Chemical Industries Limited,
Plastics Division,
Black Fan Road, Welwyn Garden City,
Herts. A 943

BRITISH RAILWAYS
LONDON MIDLAND REGION

have employment at Euston for

STRUCTURAL ENGINEERS
(REFERENCE 91)

Should be capable of the design and detailing of railway structures in steel, reinforced and pre-stressed concrete. Membership of the Institution of Civil Engineers or the Institution of Structural Engineers desirable.

ENGINEERING ASSISTANTS
(REFERENCE 92)

Should have experience in rail track layouts and general civil engineering work. Should be capable of preparing schemes on own initiative.

Salary range £833 to £985 per annum. Superannuation Scheme, five-day week, residential and other travelling facilities.

Applications quoting reference and giving details of age, experience and educational background to CHIEF CIVIL ENGINEER, BRITISH RAILWAYS, LONDON MIDLAND REGION, 5a, EUSTON GROVE, LONDON, N.W.1. B 129

BABCOCK & WILCOX
LTD.

Nuclear Power Programme

requires

ENGINEERING DRAUGHTSMEN

for Project and Contract work in their expanding Atomic Energy Department.

A knowledge of Steam-raising Plant, similar Heavy Engineering and also of Mechanisms Engineering is desirable but not essential.

Good chances of promotion for men with initiative. Five-day week. Superannuation scheme in operation. Canteen in building. Social facilities.

Write, giving details of age, experience and qualifications to:—

ASSISTANT SECRETARY,
209 EUSTON RD., LONDON, N.W.1
B 186

DESIGN DRAUGHTSMAN

A food manufacturing company in the home counties invites applications for the post of DESIGN DRAUGHTSMAN to work on various engineering projects, in a highly mechanised mass production factory. The Design Draughtsman will work on projects including intricate mechanical machinery, process plant, packaging equipment, conveyor systems and plant layout. Candidates should be between 25 and 35 years of age, possess Higher National Certificate in Mechanical Engineering (or equivalent qualifications) and have experience in one of the above fields, and should have progressive ideas for the design of new plant. The successful applicant will be appointed at a salary level of approximately

£1450 on a range up to £1830

plus non-contributory pension benefits, etc.

Please write giving a detailed account of age, experience and qualifications to the PERSONNEL MANAGER, BOX B 189, *Offices of* ENGINEERING.

THE ASSOCIATED PORTLAND CEMENT MANUFACTURERS LIMITED

require several

SENIOR AND JUNIOR MECHANICAL ENGINEERING DRAUGHTSMEN

for work on plant layout schemes and details at Head Office, Westminster.

Experience in heavy machinery, plant layout and mechanical handling an advantage. Applicants with H.N.C. in Mechanical Engineering preferred for Senior Posts.

The Company offers good salaries and working conditions, pension fund and profit sharing bonus.

Replies giving particulars of training and experience will be treated in full confidence and should be sent to the following, marked "Personal":—

THE MANAGER,
CENTRAL ENGINEERING DEPARTMENT,
ASSOCIATED PORTLAND CEMENT MANUFACTURERS, LTD.,
PORTLAND HOUSE, TOTHILL STREET,
LONDON, S.W.1. B 159

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LIMITED,

PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1.

Consequent to long term increased activities we have vacancies for the following staff:-

Progress Clerks preferably with general engineering knowledge and experience.

Specification writers for Furnaces and associated steelworks equipment.

Engineering Clerks for general Drawing Office duties.

Training will be given to suitable applicants possessing intelligence, initiative and general knowledge.

Pension Scheme, five-day week:

Apply in confidence to:-

General Manager, Furnace Division

B172

Esso PIPELINE PROJECT

The following vacancies occur in Esso's newly formed Pipeline Division, responsible for the recently announced £2½ million Fawley-London pipeline project. There are considerable opportunities for training, experience and advancement for the right men.

MECHANICAL ENGINEER

Applicants should be under 35 and have an engineering degree and/or be Associate Members or Graduates of the Institution of Mechanical Engineers. Good practical training is essential, preferably with design experience on cross-country pipelines and knowledge of fluid flow calculations and pump selection.

MECHANICAL DESIGN DRAUGHTSMAN

Applicants should be under 40 and have a Higher or Ordinary National Certificate in Mechanical Engineering and good workshop training and drawing office experience. Experience of cross-country pipeline work or plant layout is desirable.

The successful applicants will be based on London, but some travelling in the U.K. may be involved. Starting salaries will depend on age, experience and qualifications. There is a contributory Pension Plan and other associated benefits.

Apply, giving full personal details, to MANAGER, RECRUITMENT and TRAINING,

ESSO PETROLEUM COMPANY LIMITED.
16 CHARLES II STREET, LONDON, S.W.1,
quoting reference number PP3. B195

THE GENERAL ELECTRIC COMPANY LIMITED

ATOMIC ENERGY DIVISION

invite applications from the following for experimental and development work in connection with the design and construction of civil and nuclear power stations:—

University Graduates (Ref. DWB/15).

Preferably under 30 years of age, interested in the basic design and analysis of complex steel structures, stress analysis of shells, evaluation of temperature stress distributions, mechanical vibrations and pipework calculations. Although previous experience of this type of work is not essential, the successful candidate should have an honours degree in mechanical or civil engineering.

Young Mechanical Engineer (Ref. DWB/16).

To join a team engaged on experimental and development work on mechanical engineering problems. Qualifications required are an engineering degree or equivalent, D.O. and workshop experience, and an active versatile mind not constrained to conventional thinking.

Laboratory Assistants (Ref. DWB/17)

For the Instrument and Electrical Section. Duties will involve the development and testing of electro-mechanical and electronic measuring and control devices; maintenance of electrical measuring, controlling and recording instruments; location and rectification of faults on a wide variety of electronic instruments. Applicants should have had experience in at least one of these fields, possess their O.N.C. in Electrical Engineering and be continuing their studies towards H.N.C.

Applications with a brief résumé of qualifications and experience should be sent to the

PERSONNEL MANAGER,
THE GENERAL ELECTRIC COMPANY LIMITED, ERITH, KENT,
quoting the appropriate reference. B 152

VACANCY IN THE DAIRY SERVICE DEPARTMENT

A vacancy exists in the Dairy Service Department for a person to deal with work of a technical/practical nature, preferably with some qualification in chemistry or Food Technology but must also have a very definite leaning towards mechanical engineering. Alternatively a mechanical engineer might suit. The work will mostly deal with food processing equipment and the successful candidate will operate from Crawley, although considerable travelling is envisaged.—Apply in writing giving details of age, experience and salary required, to PERSONNEL OFFICER, THE A.P.V. CO., LTD., MANOR ROYAL, CRAWLEY, SUSSEX. B 145

CIVIL ENGINEERING ASSISTANT

CIVIL ENGINEERING ASSISTANTS required for site work on contracts. The work is varied and interesting with opportunities for promotion and study of new methods. Applicants should be between the ages of 26 and 32, and hold a degree in civil engineering or equivalent. They should have had a minimum of 3 years with a contractor on site work which must have included setting out and progress measurement. Experience in design of formwork and other temporary works, control of concrete quality would be an advantage.

Apply in writing, giving brief details of qualifications and experience, also stating age and salary required, to: THE CHIEF ENGINEER, THE DEMOLITION & CONSTRUCTION CO., LTD., 3, ST. JAMES'S SQUARE, S.W.1. B 150

ENGINEER

ENGINEER required with experience in the installation of light mechanical packing machinery, by Johnson & Johnson Export Ltd. Age 28-40. Engineering degree essential, together with knowledge of European languages, preferably French. Successful applicant must be prepared to travel abroad. Commencing salary £1500 per annum.—Apply, giving full information, to PERSONNEL MANAGER, JOHNSON & JOHNSON (GREAT BRITAIN), LTD., WREXHAM INDUSTRIAL ESTATE, WREXHAM. B 139

ENGINEER

ENGINEER required to join development laboratory for work on a wide range of industrial instruments. Applicants must hold degree or H.N.C. in Mechanical Engineering or Physics, and have previous development experience, preferably in the Instrument Industry. Housing available.—Please write, giving full details to the CHIEF DESIGN AND DEVELOPMENT ENGINEER, K.D.G. INSTRUMENTS, LTD., MANOR ROYAL, CRAWLEY, SUSSEX. B 138

JUNIOR CIVIL ENGINEER

JUNIOR CIVIL ENGINEERS required to work on sites with excellent opportunities for training. Applicants should be graduates or equivalent and should be between the ages of 20 and 26.

Apply in writing giving brief details of qualifications and experience (including vacation course work), also stating age, to: THE CHIEF ENGINEER, THE DEMOLITION & CONSTRUCTION CO., LTD., 3, ST. JAMES'S SQUARE, S.W.1. B 151

PETROLEUM ENGINEERS

BP requires PETROLEUM ENGINEERS for overseas service in its Exploration Department. Applicants, aged between 21-27, must possess an Honours Degree in Physics, Mechanical Engineering or Petroleum Engineering. Previous oilfield experience would be an advantage. Salary according to age, qualifications and experience. National Service obligations must have been fulfilled.—Write, stating age and full details of qualifications and experience, quoting F579, to BOX 3234, c/o 191, GRESHAM HOUSE, E.C.2. B 148

SUPERINTENDENT ENGINEER

Wanted by Eastern Canadian Shipyard. SUPERINTENDENT ENGINEER. To take control of Machine Shop, Pipe Fitting Shop, Fitters and Boilermakers. Applicants should have a good knowledge of marine engineering both steam and diesel, served a recognised apprenticeship and hold a first class M.O.T. Certificate. Knowledge of French an advantage although not essential. Applicants will be interviewed during March, 1960.—BOX B 164, Offices of ENGINEERING.

FURNACE DESIGN DRAUGHTSMEN

PILKINGTON BROTHERS LIMITED have vacancies for FURNACE DESIGN DRAUGHTSMEN. Experience in the design of glass furnaces is an advantage, but not essential.

Applications stating age and experience should be addressed to GROUP STAFF DEPARTMENT, PILKINGTON BROTHERS LIMITED, GROVE STREET, ST. HELENS, LANCASHIRE. B 160

ASSISTANT RESIDENT ENGINEERS

Water Tube Boiler Contractor requires ASSISTANT RESIDENT ENGINEERS for site construction. Previous shop and site experience is essential and technical qualifications to H.N.C. would be an advantage. Preferably age group 28-40. Salary would depend on experience and qualifications but would not be less than £800 p.a. plus subsistence allowance when working on site. Pension Scheme.—Full particulars of age, qualifications and career, quoting reference WT7, should be sent to BOX B176, Offices of ENGINEERING.

JUNIOR MECHANICAL ENGINEER OR DRAUGHTSMAN

With experience in chemical or similar engineering, required now by Arthur Guinness, Son & Co. (Dublin) Limited, St. James's Gate, Dublin. Age limit 26; must have H.N.C. or equivalent in engineering, good practical apprenticeship, and at least one year's drawing office experience on process plant and general engineering.

Starting salary in range £640 to £970 p.a., according to age and qualifications with annual advances. Substantial amenities and excellent prospects for progressive man.

Reply to CHIEF ENGINEER with particulars of age, education, training, and experience, in that order.

Expenses paid if selected for interview. B 194

SALES ENGINEER

SALES ENGINEER, resident Sheffield area, to represent South London company manufacturing air treatment and water cooling plants. Knowledge of the products and their applications essential.—Write BOX B 184, Offices of ENGINEERING.

DEVELOPMENT ENGINEER

DEVELOPMENT ENGINEER, 25-30 years, minimum educational qualification H.N.C., to investigate problems relating to air movement and cleaning leading to development of new plant. Interesting job with good prospects for right man. Location: Surrey.—Write BOX B 183, Offices of ENGINEERING.

DETAIL DRAUGHTSMEN

EXPERIENCED DETAIL DRAUGHTSMEN required in Northern Ireland for development work on a.c. motors, 1-500 h.p. Draughtsmen also required for detail and, if possible, design of a.c. control gear for similar h.p. ratings. Good salary and pension scheme.—Reply giving full particulars of age, qualifications and experience to BOX B 182, Offices of ENGINEERING.

APPOINTMENTS WANTED

ENGINEER

ENGINEER seeks change, experience Medium Plant Layout and Services. Low Pressure Vessels with cooling, cold stores, MS ST. ST. and Copper fabrication, heat recovery (jet condensers and calorifiers), powder filling (conveyor layouts and auto machines). Pumps and circuits. Specifications and installations. H.N.C. Seeks post with broad scope. Age 46. London and Kent.—BOX B 136, Offices of ENGINEERING

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates: per page (12 in. by 9 in.)	£100
per half page	£54
per quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates: per page (12 in. by 9 in.)	£100
per half page	£54
per quarter page	£29
per single column inch	£2 14s.

c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line	4s. 6d
(Minimum charge 18s.)	

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

Company Meetings

Quarter page £29 : half page £54 : full page £100

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing Screen 100.

ORDERS TO: "Engineering," 36, Bedford Street, London, W.C.2 Telephone TEMple Bar 3663

Companies

Hopes and Probabilities for Hawker

Mr. Duncan Sandys, the Aviation Minister, hardly expected cries of joy from the leaders of the aircraft industry over the mergers that followed his appointment. Now Sir Thomas Sopwith, chairman of the HAWKER SIDDELEY group, has cast a cool look at his operations in making offers for DE HAVILLAND and BLACKBURN.

"We were not particularly anxious to add to our aircraft interests in the UK," says Sir Thomas in his annual statement. And indeed the record of the past financial year shows that in the air interests of the vast Hawker Siddeley empire the proportion of hope to certainty is greater than in its diversified general interests, which before the latest moves occupied some three quarters of the activity of the group.

On the industrial side BRUSH ELECTRICAL delivered 44 of a BRITISH TRANSPORT COMMISSION order for 60 diesel electric locomotives during the year and the BTC followed up with an order for another 100. Large transformer orders came in from the CENTRAL and AREA ELECTRICITY GENERATING BOARDS and the switchgear and rotating machines divisions continued to expand. The range of steam and industrial gas turbines and turbo-blowers was widened by an arrangement reached with the United States' DRESSER GROUP.

The three largest transformers ever made by the group's FULLER ELECTRIC were exported and MIRLEES, with a good order position, were receiving an encouraging number of repeat orders. The Jason reactor, by the HAWKER SIDDELEY NUCLEAR POWER company was opened by Sir John Cockcroft and a Jason is to be sold to the ATOMIC ENERGY AUTHORITY. Through its GLOSTER EQUIPMENT company the group is making a varied batch of products from vending machines, forage harvesters, fire appliances, tank refuellers and sweepers for various purposes.

Aircraft

On the aviation side the word obsolescence looms up when the group's aircraft flying for the Royal Air Force and others are listed. The list runs—Hunter, Sea Hawk, Vulcan, Javelin, Gnat and the two-seat Hunter Trainer. Of these to mention only one, the Sea Hawk, has now been in production for ten years.

The future for the company's aircraft is where risks appear to be as numerous as hopes. Certainly one of the most likely looking hopes is the Avro 748, a 36 to 40 seat turbo-prop, low first cost, cheap to operate transport whose prototype is expected to fly within a few months. This could be the plane to replace the multitudinous DC 3. Hawker Siddeley have negotiated a licence with the Indian Government for the manufacture for ten years of Avro 748's as replacements of the DC 3's now used by the Indian Air Force. On the home market two independents have ordered Avro 748's and BOAC ASSOCIATE companies are "in close touch."

Research and development contracts are being negotiated for the Hawker P 1127 vertical take-off fighter and the group is hoping that the RAF may order numbers of the Gnat two-seater as an advanced trainer.

Both in opening his statement and in his conclusion Sir Thomas referred to government aid for the aircraft industry. The Government, he hoped, would keep faith and place the contracts necessary for the group to function "as the strongest, technical scientific and production company in the business." To denude the industry of support now would imperil "one of our greatest sources of industrial strength."

The chairman commended to the Government the urgent need for it vigorously to back industry in its overseas sales by making possible long-term export credits of the kind freely used by competitors. The view that to neglect this is to lose much business comes from the leader of an organisation whose turnover last year reached £260 million.

Substantial Capital Investment expected

When all allowances have been made for management skill, labour relations and quality of plant, the essential remaining factor for business operations is *confidence*.

The totally different picture of 1960 capital investment in industry, now presented by the Board of Trade, from what its survey suggested last midsummer must vitally change the atmosphere in which the heavy engineering industries will operate. An average increase over the main groups of industries of 16 per cent above the 1959 level is now expected.

A 14 per cent increase over 1959 is predicted on fixed assets of manufacturing industry. This is made up of 17 per cent more on plant, machinery and vehicles and about 8 per cent more on building work. These are all major advances on the picture drawn some months ago from the mid-summer replies of the same companies from whom the Board of Trade gathers the facts. Much of the revision comes from the iron and steel firms and the motor car industry. Both are now expected to spend 50 per cent more in 1960 than in 1959 although their provisional estimates showed no such increase.

There are two possibilities and both leave room for doubt. One is that the companies concerned had not reached final decisions and, presumably for policy reasons, did not acquaint the Board of Trade in advance with outline plans. The other is that the prospects for 1960 should be regarded with "a somewhat greater measure of doubt than usual." What the usual is here is itself doubtful but nothing in the present motor car boom or the demand for at any rate sheet steel suggests that more than usual doubt would be other than ill founded. Leaving iron and steel and cars out the rest of manufacturing industry is expected to increase capital expenditure by 5 per cent.

Other industries and services suggest a rise in capital spending of 20 per cent, made up of an increase by a third in new building, the private housing figures are obviously a potent influence, and of a fifth in outlay on plant and machinery. Vehicle spending may not be more than the high level of 1959.

The earlier report in this section, based on fewer companies, indicated that perhaps the steady rise of around 8 per cent in annual capital expenditure was coming to a halt. Undeterred by the gap between this and the figures now presented the Board of Trade puts up two, valid, reasons for looking warily at the report. They are that in this field intention is not always the equal of achievement and that the intentions of the bigger companies, which largely make the base for the report, are often quite different from those of the smaller units.

Manoeuvres in Selling Abroad

An interesting relation between import restrictions imposed by foreign governments and the setting up of manufacturing facilities abroad is made by the chairman of BROOM AND WADE, the compressor and pneumatic equipment manufacturers. Mr. H. S. "Dick" Broom (inset) in his annual statement.

By establishing overseas factories, or where necessary negotiating licensing arrangements, it is possible to overcome Government restrictions. "Dick" Broom quotes his own experience in India where the authorities do not allow the full Broomwade range to be imported. The company has made an agreement with KIRLOSKAR PNEUMATIC to produce some of the range, incorporating special components made at Broom and Wade's High Wycombe (Bucks) plant. In this way the company gets the benefit of the Indian market and is ready to increase its activities there as the Indian economy expands or as the Government's policies are liberalised.

At home the chairman announced a record consolidated profit, £851,858, a substantial improvement on the £569,434 of the year before. New high levels of demand for pneumatic tools, paint and spray equipment and small compressors made by B.E.N. PATENTS, a wholly owned subsidiary of Broom and Wade, were reached.

Control

In detailed management terms the chairman pointed out that while the group's world turnover had increased by 15 per cent the stock supporting this had risen by only 8 per cent. Much closer stock and material control in the parent company is the explanation of the improvement. A side benefit has been a stronger cash resources situation.

Overseas, apart from India, the Broom and Wade Canadian company has been establishing itself over the past eight years and is now expected to go forward much faster. The freshly formed Australian manufacturing company has shown a small profit in its first year and taken with the main Australian company sales there, have at record value. Looking ahead to the future impact of the European Common Market, Broom and Wade have a Belgian company, BROOMWADE-BELGE SA, which began operations in March of last year.

Tubes and Turnover

Labour cost increases, railway freight rises and local rating re-assessments were all absorbed into the year's costs of STEWARTS AND LLOYDS, the steel and iron products manufacturers, without affecting the price to the consumers.

There was little improvement in the amount of work to be done for the pipe requirements of the oil companies and in going after export markets the company had to quote prices against keen competition.

The outcome of all this is a drop of £3,188,000 from the previous year's trading profit before taxation to £11,077,000.

Mr. A. G. Stewart, chairman of Stewarts and Lloyds, reports in his annual statement that trading results in the final month of the financial year were notably better than in the months preceding.

On the important subject of tubes, Mr. Stewart said that 833,000 tons were despatched against 866,000 tons in the financial year ended in 1958. There was an improvement in the demand for general purpose steel tubes which picked up markedly in the latter part of the year, ending on a firm note. Home demand for quality tubes was not so encouraging but in the later months of the year there was a stronger demand for seamless tubes in the larger diameters, evidence of the gathering strength in capital investment.

Only 151,000 tons of tubes were despatched in the year to the oil industry, which was 41 per cent down on the year before. A slight pick up in the first quarter of the year was not maintained. Towards the end of the year the outlook and the order book were improving.

On this Mr. Stewart warns that the improvement was not due to an overall increase in oil company demand but rather to a few large orders. The biggest such order being for 32,000 tons of 16 in diameter pipe for the BURMAH OIL company to be used in Upper Assam. The achievement of this order was helped by the British Government's provision of finance to the Indian Government.

Despatches to export customers outside the oil industry were up 25 per cent to 232,000 tons and included a record 165,000 tons of Gas List tubes. But again competition brought prices to a lower level than in 1958.

Of considerable assistance in fully using the cold drawn seamless capacity in the first six months of the financial year are orders from Russia.

Exports of steel shot up from the previous year's 11,000 tons to 75,000 tons. What looks like a splendid effort is slightly dimmed by very low prices that had to be quoted to bring it about.

One of the Stewarts and Lloyds overseas companies (in South Africa, the Central African Federation, Ireland, Australia, New Zealand and Canada) stands out. This is Australia, where the steel used in making tubes was 295,000 tons and despatches were worth £A37,000,000.

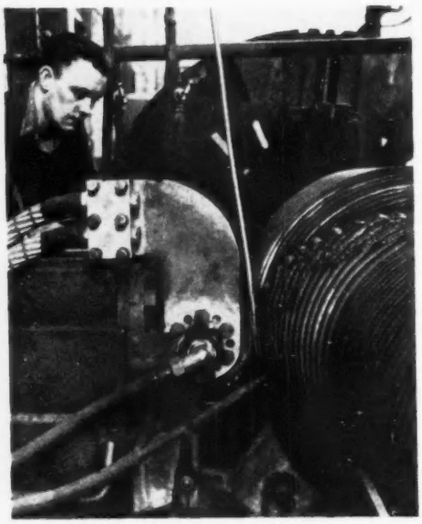
Strip Winding for High Pressure Vessels

The strip-wound method of construction for high pressure vessels, developed in this country by Vickers-Armstrongs (Engineers) Limited, Broadway, London, SW1, is of interest to all concerned in the design and construction of specialised plant, where large volumes have to be accommodated at high pressure. Chemical, nuclear and hydraulic engineers, in particular, will find it an advantage to use the method.

The wall of the vessel is built up (see Figs. 1, 2, 3 and 4) from a comparatively thin core tube, by winding layers of a locking-strip to the thickness required by the pressure involved. A special interlocking feature of the strip in its wound condition enables the longitudinal stresses to be carried in addition to the hoop stresses in the wall of the pressure vessel. The construction allows enlarged ends to be built up in order to take the anchorage of the end closures of a parallel bore. This does away with the use of forgings, except for the end covers (Fig. 1). The core tube is made of any desired rolled section steel, X-rayed and thick enough to allow the machining of the continuous spiral grooves that take the first layer of strip. This usually results in a core about 2 in thick, but it can be greater or less, depending on design conditions.

Fig. 1 (above) Strip-wound CO removal towers for ICI Limited.

Fig. 5 (below) Pressure roller and spray quencher.



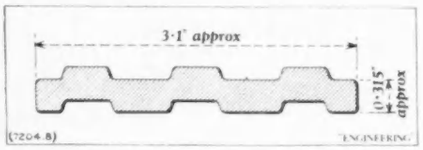


Fig. 2 Cross-section of strip.

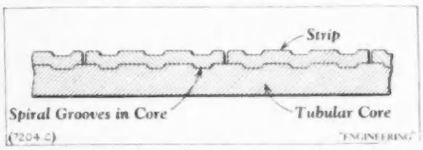


Fig. 3 Core tube showing first layer of strip.

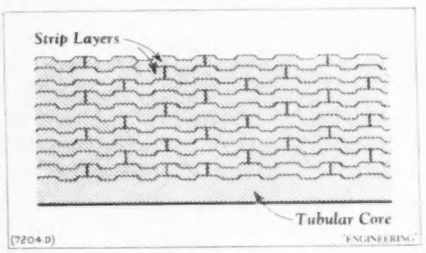
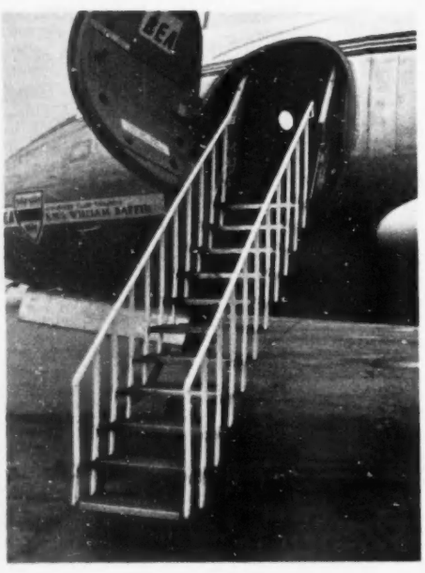


Fig. 4 Interlocking of successive layers of strip.

HOW IT IS MADE

The strip is heated electrically and continuously wound on to the core tube. A roller presses the heated strip into the receiving grooves on the outer surface of the tube, or on to the previous layer, as the case may be. The strip is then immediately quenched. This combination of heating, pressure rolling and quenching ensures intimate contact and full use of the interlocking feature of the strip (Fig. 4). The free ends of the strip at the beginning and end of each layer are secured by flash butt welding. Short lengths of strip are wound in place by moving the starting point of each layer towards the outer face and securing each end by welding. The final (outside) layer of each extremity is laid in the same way, but the coils are also welded circumferentially to each other along their edges to form a continuous shroud (Fig. 1). The outer face is finally machined and drilled to receive the anchor studs for the end cover.

Lightweight Passenger Stairway



It is now generally agreed by major airlines that, for reasons of operating and passenger safety, civil aircraft should be completely self-contained and independent of ground equipment. One obvious item for attention is the means for entering and leaving the aircraft. For quick turn-rounds, when the aircraft is on a transit stop, and has to be on the ground for the least time, built-in steps are a great advantage. It is also important, now that aircraft are larger and the passenger floor height from the ground greater to provide some means of getting passengers out quickly.

The Airscalator was designed by Strabor Limited, Aeronautical Development Engineers, 133 Rochester Road, Gravesend, Kent. It does not prevent the door being used normally in the case of a belly landing. The design is based on the lazytong principle and the stairway is placed at an angle of 45 . Each horizontal member carries a tread made of Aeroweb honeycomb panels from CIBA (ARL) Limited, Duxford, Cambridge.

When stowed in the aircraft, the stairway permits use of the door in the normal way. The weight of the Airscalator, complete with all the operating mechanism and gear, is about 189 lb. A feature of the design is that it can be fitted to existing aircraft with only a little modification.

The design strength in bending was based on a passenger load of 170 lb supported on each of the upper eight treads. This is the most severe case, although it is not the maximum load that can be supported. Passengers on the three lower treads give bending relief. Under the worst conditions proof and ultimate factors are respectively 2 and 3.

The facing sheets of the treads are of light alloy, and the upper surface is covered with a non-slip material.

Structural links and interlocking handles are of machined Elektron magnesium castings, surface-sealed with Araldite 985E and painted.

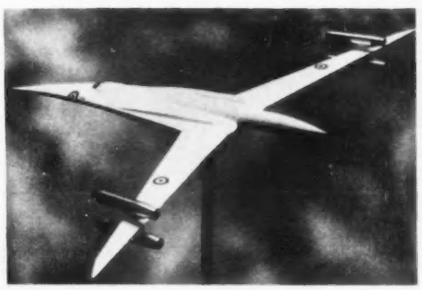
The door is operated by a separate jack and controlled by a telescopic strut connected to the forward vertical support tube. The telescopic feature enables the door to be opened by power without extending the Airscalator, or by hand in an emergency. Tread assemblies are interchangeable and may be removed, individually, by dismantling the local links. All structural links are machined to a standard jig and may be interchanged to any position. Operating jacks and operating levers, where not handed, are fully interchangeable.

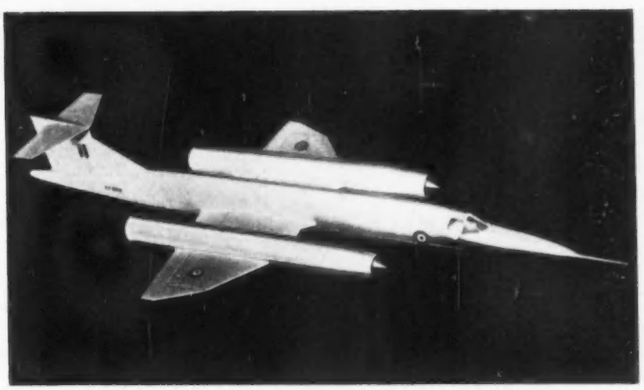
Operation is simple and straightforward and the controls consist of a switch for controlling power and a selector lever for up and down.

Vickers VC 10 jet transport, ordered by BOAC, has four Rolls-Royce Conway engines mounted rather unconventionally in pairs at the rear fuselage. It has full-span leading edge slats and trailing edge flaps.

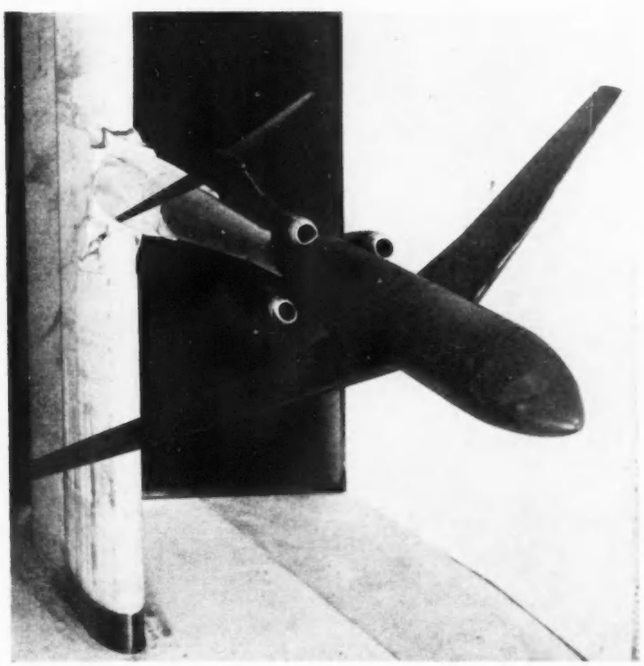
The Wallis "Swallow" variable geometry supersonic aeroplane will fly with the wings folded (above) or spread (left).

(Left) Model of space ferry design from the USA

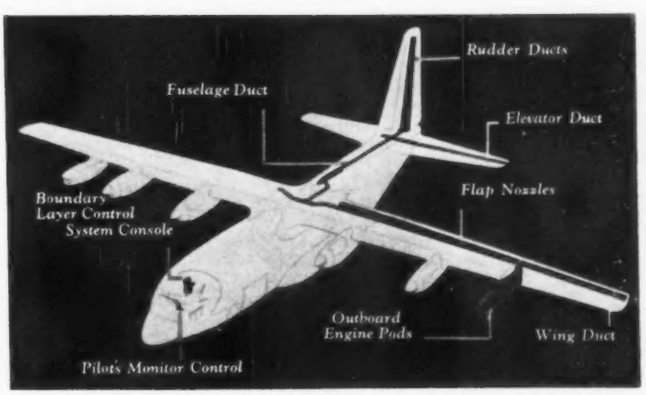




The Bristol 188 single-seat supersonic aircraft, which is expected to fly at more than 1,500 m.p.h., is of welded steel construction.



Model of the Airco DH 121 in the Aircraft Research Association's large transonic wind tunnel. It will have three rear-mounted bypass jet engines.



The Lockheed "Hercules" boundary layer control aircraft has two outboard engine pods for blowing air over the control surfaces.

Silicon Controlled Rectifier

Pioneers in semiconductor technology, and manufacturers of semiconductor devices for nearly twenty years, Associated Electrical Industries Electronic Apparatus Division announce the development of a silicon controlled rectifier.

The new device, of PNPN form, can be regarded as two transistors coupled by a common collector junction, the solid-state equivalent of the thyratron or the grid-controlled mercury-arc rectifier. It offers a high impedance (several megohms) in each direction, but can be triggered into a low impedance condition in one direction by applying a small signal to the third electrode. It has the usual solid-state advantages: smallness, absence of heater supplies and high operating efficiency.

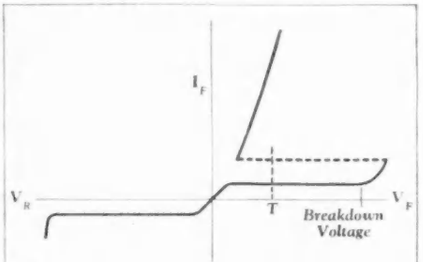
Applications are similar to those of conventional devices, and include: control of electric motors, firing of ignitrons, d.c. to a.c. conversion.

The present range of controlled rectifiers is such that loads up to 10 amp at 25 to 300 volts peak inverse voltage can be handled. Some typical types appear in the table.

Ratings of AEI Controlled Rectifiers

Rectifier type	Peak inverse voltage, volts	Mean d.c. forward current, amps	Rectifier type	Peak inverse voltage volts,	Mean d.c. forward current, amps
CX10/25 ..	25	10	CX5/25	25	5
CX10/50 ..	50	10	CX5/50	50	5
CX10/75 ..	75	10	CX5/75	75	5
CX10/100 ..	100	10	CX5/100	100	5
CX10/150 ..	150	10	CX5/150	150	5
CX10/200 ..	200	10	CX5/200	200	5
CX10/250 ..	250	10	CX5/250	250	5
CX10/300 ..	300	10	CX5/300	300	5

Typical trigger requirements: 50 MA, 2 volts.
Typical forward volt drop, CX10 types: 1·5 volts
Typical forward volt drop, CX5 types: 2·5 volts



Volt-Amp Characteristics of Controlled Rectifier

(7604 B) "ENGINEERING"

The volt-amp characteristic of a controlled rectifier is shown in the diagram. In the reverse direction it is almost identical with that of a simple silicon rectifier. The forward direction is a mirror image of the reverse characteristic up to the breakdown voltage. If a small current (10 to 100 milliamp) is applied to the control electrode when the forward voltage is below breakdown (e.g. at T) the rectifier will remain conducting until the voltage across it falls to almost zero. A common method employed is to control the output of the rectifier by changing the phase of the trigger current in relation to the a.c. voltage applied to the rectifier.

Range of Outboard Motors

Lively performance and ample power are important characteristics of the streamlined outboard motors from Perkins Outboard Motors Limited, Eastfield, Peterborough. The engines are of 6, 16 and 35 h.p. These outboards have 2-cylinder 2-stroke power heads and develop their maximum power at 4,500 r.p.m. They are water-cooled and use a petrol-oil two-stroke mixture fuel. The engines have forward, neutral and reverse gears. The 6 and 16 h.p. motors have automatic rewind starting, and electric starting is available for the 16 h.p. if desired. The 35 h.p. motor has electric starting.

Design features

An important feature of the 35 h.p. outboard is the use of poppet inlet valves to the crankcase. These ensure a smooth flow of power at the normal operating speeds, regardless of varying atmospheric pressures. Inherently quieter than reed valves, they dispense with a bulky silencer and result in a lighter, faster engine, combining maximum load-carrying with economy. They increase the initial drive, so that the boat can plane faster and "bring up" skiers more easily. Another feature of this engine is the magneto alternator specially designed for it by Bendix. This magneto increases the output at the spark plug while the primary current is decreased, gives easier starting and longer life for plugs and points.

The system produces 18 kV at full throttle. Extra power is provided through the low tension ignition system and enough current is generated to keep the battery charged. The unit ensures a constant supply of power for the spark plugs as well as providing power for the navigation lights.

Power generated at the power head of Perkins outboard engines is delivered direct to the propellers through the specially designed lower unit. The unit is housed in a streamlined one-piece casing with a minimum number of parts. The special gear assembly allows closer tolerances, involves fewer parts and results in more efficient operation with less maintenance.

The outboards also have a simple method of adjusting the angle of the motor on the transom, an important feature from the operation point of view. The motors can, in fact, be adjusted to the most suitable angle up to 20°.

Further characteristics

Other features include:—specially treated aluminium parts, nylon bearings in all external throttle controls, to protect them from corrosion; and concentric-bowl carburettors to ensure a steady fuel supply at all speeds and angles.

Illustrated (left) is a Perkins 16 h.p. model.

Gondola Ski Lift in Canada

It is expected that the new gondola ski lift at Banff, Alberta, will be one of Canada's top tourist attractions, as well as a boon to skiers. The first of its kind in North America, the lift will carry passengers to the peak of 7,487 ft Sulphur Mountain. Steelwork for the towers was fabricated and erected by Dominion Bridge Company Limited in Calgary.

Each of the 38 glass-enclosed gondolas takes four passengers, so that a total of 460 an hour can be transported at peak load. Rate of ascent is 10 ft per sec, the trip to the peak taking about 9 min. The ascent varies from 20 to 37° and is one of the steepest for any lift in the world. The average angle of climb is 29°. The length of the lift from terminal to terminal is 5,280 ft with a vertical rise of 2,300 ft.

Owned by the Banff Sulphur Mountain Lift Company, the lift was designed by Bell Engineering Works Limited, Lucerne, Switzerland. There are only 12 similar lifts in the world and these have carried 10 million without accident.

On the Shelf

By Frank H. Smith

I do love these readership surveys that magazines conduct so that they can impress their advertisers. How bright they are, too. The other day I had a letter from one saying that they were missing vital details about me. The letter was addressed to me in my position as librarian of a technical body and the two questions I had to answer were the name of my employer and the position I held. Not being one to miss a chance, I added to the official answers " This, surely, is self-evident."

A long news release from the Instrument Society of America (313 Sixth Avenue, Pittsburgh 22, Pennsylvania) tells of their intention to assembly, classify, collate, edit and publish a comprehensive compendium of up-to-date information on all known transducers. So if any of you happen to transduce, get in touch with the body at once or you will be out of it. A transducer, by the way, is any device which enables the conversion of any physical, chemical or biological phenomenon into an electrical, hydraulic, pneumatic, mechanical, optical and other signal for transmission, recording, measurement, analysis, actuation, output or control. Transducers have been referred to as pick-ups, sensing elements, primary elements, command devices, sensors, detectors and probes. So there you are, Oxford, I've done the job for you on that new supplement of yours.

If I have not got my paper clips and my compliments slips mixed (it's extraordinary what happens when a few papers are bunged into one drawer) the Soviet Committee for the International Geophysical Year have sent us a *Bibliography of Literature in Russian*. There's more to the title but my translitterateur (?) has failed to do it for me. However, if you address a request to the Committee which is a subsection of the Academie des Sciences de L'URSS at Moscow I would not mind betting you get one back eventually. If you can read Russian it should be useful.

I've been getting a bit behind so perhaps I'm a bit late with Heffer's (of Cambridge) Catalogue No. 720, " Books, Antiquarian, Rare, Modern, including an Important Shakespeare Library." Do you know that little thing about Shakespear? That is supposed to be the spelling with which he signed his will. This contains four vowels and six consonants. Take the 46th Psalm. Count 46 words from the beginning (shake) and 46 from the end (spear). Good? I'm doing all this from memory so do not blame me if it does not work out.

A useful bibliography from Unesco is that of monolingual, scientific and technical glossaries by Eugen Wüser, Volume II of which (Miscellaneous sources) has just appeared. (At least, it would have just appeared had I written this a month earlier.) I've looked in all the usual places for the price and found it on the back cover—12*s* 6*d* and HMSO should oblige. The items are in UDC order and it is well indexed.

Very considerately, the Russians give the English title and authors of *Library of the Academy of Sciences of the U.S.S.R.: Guide-Book*. But there it stops, which is enough to drive anybody interested in the thing barmy with frustration, especially as the photographs imply really interesting material. If you are lucky enough to know the language, apply to Moscow for a copy.

An interesting article in *Mechanical Engineering* (ASME) for December on mechanical power transmission deals with belts, chains and gears. It is a condensation of ASME paper 59-MD-5 but the bibliography of 42 references is in the journal quoted.

Van Nostrand's latest bulletin includes *Nuclear Physics and Atomic Energy*, by Béné, at 30*s*. This is a *Glossaria Interpretum*, whatever that may be, in four languages—ours, Fr., Ger., and Russ.

Furnace Alchemy

The Physical Chemistry of Steelmaking. Edited by JOHN F. ELLIOTT. Proceedings of the Conference on The Physical Chemistry of Iron and Steelmaking held at Dedham, Massachusetts, 28 May to 3 June, 1956. *The Technology Press of The Massachusetts Institute of Technology; John Wiley and Sons, New York*, and *Chapman and Hall, London*. (120*s*)

In June, 1956, some 50 men from America and Europe spent a week together on a country estate in Massachusetts discussing the fundamental aspects of the equilibrium and kinetics of iron and steelmaking reactions—collectively perhaps best described as " an activity of physical chemists." The 43 formal papers, together with a very brief summary of the discussions which followed, have been edited by Professor Elliott of the Massachusetts Institute of Technology in this 250 page volume.

As is rightly pointed out in the preface, the primary benefits of a conference of this type consist to those who take part not least in the informal discussions, which of course are not recorded. Nevertheless the reader has something to gain from the printed record for, as would be expected from the leading international authorities, each author has something useful to contribute to the literature, either with new results, progress reports on current research or reviews of a particular subject. Naturally continuity of style or thought would not be expected but this is not a serious disadvantage.

A feature of the conference was a discussion on kinetics and reaction rates in eight of the papers. Recognition of the growing importance of these aspects, which have long been subsidiary to equilibrium considerations, is to be welcomed. Four papers on the application of fundamental data to process development are of greatest immediate interest to the blast-furnaceman and steelmaker. Many, however, are likely to give up the unequal struggle with specialist language and symbolism for the gulf between the art and the science is still wide. Recognition of this weakness and of the need for trained men who know both physical chemistry and practical steelmaking is a recurring theme in an interesting collection of short papers on research planning. In this group, also, the record of the gaps in the knowledge of the physical chemist and statements of future projects in various laboratories are worth noting.

This publication is for the specialist or student of process metallurgy and demands a knowledge of the techniques of the physicochemical approach to iron and steel making problems. It is unfortunate that these proceedings have taken so long to publish but the final form of clear bold presentation is excellent and a credit to the editor, the organisers of the conference and the publishers.

J. MACKENZIE

Seeking Nuclear Lebensraum

Kern-Wissenschaft und-Technik. Dechema-Monographien Nr. 411-425. Published for *Deutsche Gesellschaft für Chemisches Apparatewesen, Rheingau-Allee 25, Frankfurt (Main) 7*, by *Verlag Chemie GmbH, Bergstrasse, Weinheim, Germany*. (24 *DM*, members of Dechema, and 30 *DM* non-members.)

" Nuclear Science and Technology " is one of a series of monographs published for the Dechema, a German institute of chemical engineering. Development and technology in the chemical industry normally form the subject matter of these monographs, but this latest volume gives the full text of 15 papers which were presented at the second European Congresss of Chemical Engineering, 1958, which was devoted to nuclear topics. The papers cover a wide range in the field of nuclear engineering and their quality is such as to have given to the Frankfurt Congress the flavour of a miniature Geneva Conference. Four of the papers are devoted to reactor engineering, four to metallurgy and chemistry, and the remainder to the industrial and biological uses of radiation and radioactive materials. The authors are authorities in their own fields and short biographies are provided.

The first paper, " Trends in the Field of Fuel Elements for Heterogeneous Reactors," includes an interesting discussion of the economics of enriched fuel. A graph showing increase in fuel cost against percentage enrichment, compiled from prices quoted by the United States Atomic Energy Commission, emphasises the scope in the choice of fuels, which is open to Germany and other European countries, and their consequent reluctance to embark on a large-scale programme of natural-uranium fuelled reactors. The advantages in the use of uranium dioxide and carbides are discussed, together with some of the drawbacks, such as the difficulty of obtaining good heat transfer between the uranium dioxide and the fuel element sheath. The author refers to the development of unsheathed fuel elements for gas-cooled reactors but does not develop what could be a very debatable subject. Developments in new canning materials, methods of manufacture and the importance of standardisation are reviewed and an up-to-date picture is provided of the whole field of fuel-element development, together with some of the more promising avenues.

" Instrumentation and Control of Research Reactors " describes the control circuit of the natural-uranium heavy-water moderated reactor at Karlsruhe. The circuit is conventional in its measurement of neutron flux—by BF_3 counters—and the derivation of the reactor period, while safety circuits are based on the " two out of three" system.

" Chemical and Electrochemical Aspects of Reactor Corrosion " begins with an introduction to the problems of corrosion encountered in the operation of nuclear reactors. The significance of electrochemical kinetics in the understanding of the phenomena encountered at the interface of a metal and its surrounding medium is shown, together with the manner in which reactor conditions affect this interface. The theoretical treatment of the problem concludes that the fission process could be affected by the complex reactions taking place in the film between the metal and its environment and that threshold potentials for these effects exist at the metal-film and the film-solution boundaries. Examples of these effects are quoted in relation to the Oak Ridge homogeneous reactor HRE-2, which has recently completed 1,600 hours uninterrupted operation, and the water-cooled reactor for the submarine Nautilus.

The use of radioactive hydrogen sulphide, adsorbed on to a wide range of metals, as a possible method of providing information on the surface structure of alloys, and the development of lead-glass windows for " hot " laboratories are unusual partners, but the papers on these subjects demonstrate the range of interest covered by the conference.

The industrial uses of radioactive isotopes form the subject of several of the papers, illustrating the diversity of the widening fields of application, such as the measurement of control of thickness, density, homogeneity, and composition of materials, the measurement of time and velocity, in the realms of pest control, water engineering and wear analyses on diesel and petrol engine cylinders.

The subjects of the papers are varied, but

their treatment is not so abstruse that their universal appeal is reduced, and the nuclear engineer would find them a fruitful and interesting series.

Kerntechnik. By WOLFGANG RIEZLER and WILHELM WALCHER. *B. G. Teubner Verlagsgesellschaft, Blumenstr. 27 und 29, Stuttgart, Germany.* (150 *DM*)

The ever increasing volume of literature dealing with atomic energy has produced many similar books, in which the same subjects have been considered in differing degrees of detail. Most authors have concentrated on theoretical reactor physics, and the numerous reactor systems have been quoted in detail as practical examples of the applications of theory. To date, however, the complete field of nuclear engineering has been adequately covered in one volume by very few authors.

The authors of *Kerntechnik* have set out to produce a single book which could become a work of reference not only for the theoretical aspects of nuclear energy but also for the purely practical techniques. In this aim they have admirably succeeded, for the scope of this book and the detail in which it is presented is a considerable step forward from similar earlier volumes.

The two principal authors, Dr. W. Riezler, and Dr. W. Walcher, have been assisted by over forty contributors all of whom are either teaching or working in nuclear energy.

The book begins with an introduction to the fundamentals of nuclear physics, presented in such a manner as to place the minimum of strain on the reader's theoretical background and liberally illustrated with diagrams. The technical problems peculiar to nuclear energy are then dealt with in commendable detail, from the technology and metallurgy of reactor materials, including fuel element manufacture, coolant, moderators, the chemistry and separation of radioactive isotopes, manufacture of heavy water, enrichment of uranium to the handling and disposal of active wastes. "Hot" laboratories and cells, with their special handling techniques and viewing methods, radiation and shielding materials, are fully described, and the advisability of observing such precautions is emphasised by pictures of an irradiated hand, parts of which have been amputated, which is referred to in the section on the biological effects of radiation, where full details of the recommended exposure levels are included.

While the section on reactors gives a very full treatment of reactor theory, heat transfer, control system and all the other theoretical techniques involved, equal attention is given to such practical problems as fuel cycles, determination of optimum temperatures for economic performance and flux flattening. The authors are to be particularly congratulated on their meticulous attention to the technical aspects of reactor safety, which has been almost ignored in previous similar books. A detailed review of the principal factors affecting reactor safety is provided and, even here, practical examples are discussed by reference to the accidents with NRX, EBR-1 and the Windscale reactor.

Controlled thermonuclear fusion devices are both theoretically described and practically illustrated in sufficient detail to give a substantial introduction to this potentially important subject.

The final chapter, of 40 pages, covers the economic factors influencing the generation of nuclear power, and a complete breakdown is given of the capital and operating costs of two competitive types of reactor, the American PWR and the British Calder type reactor. Also included is a section on the legal and insurance obligations to be met in Germany in the establishment of a nuclear reactor.

The scope of the work and the detail in which it has been written are greater than that of any similar single volume, and only by the use of close printing has its size been kept to a mammoth 1,000 pages, with 435 figures and 164 tables. Despite the large number of contributors there is no lack of coherence in the development of the subject and there can be few people working, studying or teaching in the field of atomic energy, whether theoretically or practically, who could not gain from reading this book.

H. W. CURTIS

Stretch in Time

Creep of Engineering Materials. By IAIN FINNIE and WILLIAM R. HELLER. *McGraw-Hill.* (89*s*)

An unusual feature of this new book is the wide range of topics covered. The authors discuss such aspects as the experimental measurement of creep, the metal physics of the deformation processes in different classes of materials, and stress-analysis problems to which several chapters are devoted. Most of the book concerns the creep of metals, but again, in the discussion of materials the coverage is very wide, and includes plastics and aggregate materials such as concrete and asphalt. On balance the wide range of the book is probably an advantage, although some readers will be irritated by the number of sections that are of no interest to them.

The section on stress analysis, together with the bibliography provides a good coverage of the large amount of work that has been published on the subject. Problems of multiaxial creep, together with examples, are discussed and method of solution proposed, but these must be considered somewhat tentative in the absence of further experimental verification.

The design engineer or the research metallurgist will find this a useful addition to the literature, and in particular the sections dealing with the extrapolation of data are welcome as they give an up-to-date account of the present ideas on the interpretation of experimental results.

R. B. HILL

The Enigma of Colour Vision

Visual Problems of Colour: a Symposium held at the National Physical Laboratory, September, 1957. 2 volumes. *Her Majesty's Stationery Office.* (42*s*)

Colour vision, as a scientific problem, overlaps a great many different fields, the major ones being mathematics, physics, biophysics, psychophysics, physiology, biology, biochemistry and psychology; and recent years have seen an enormous growth of interest in all its widespread ramifications, both practical and theoretical. Knowledge in the field progresses at such a rate as to warrant, almost annually, international symposia on one theme or another, devoted to expositions of new experiments, of new measurements, and of new interpretations and theories.

It is perhaps helpful to pause to consider, for a moment, the deeper meaning of this great breadth of scientific endeavour. Too often is it said that "many different people may contribute to this or that field," or that "this field invades many others," or that "because so many people are working in it, science nowadays progresses so much faster than it used to," and so forth, while possessing only the most casual awareness of what such statements imply. First, of course, general scientific research has grown from a leisure-time activity of landed gentry into an activity which, as many others, has become accredited with the approbative title of a "profession."

But to say that research workers from many fields collaborate in the field of colour vision is to say that it has not yet attained sufficiently clear and unenigmatic a social definition to warrant the title of profession in itself. Many professionals work in it; but in this alone, one is not yet a professional. (Perhaps one never will be!) Of course, there exist professional colourists, dyers, colour consultants, photometrists, illuminating engineers, and so on, but these are not research scientists in the same sense that, for example, bacteriologists are or nuclear physicists are.

Thus, those who carry out colour vision research are first psychologists, first physiologists, first physicists, first biochemists, or first mathematicians, and only then "colour vision specialists." The background of these workers is equally as diverse as their titles, hence there is no prescribed training (and there will probably be none for many years to come), no agreed programme of study and apprenticeship which would unerringly prepare one for work in this field, as one might train for say palentology, for example. Somehow, people just drift into it, a bit haphazardly. To be master in it is to be master of several professions—hence few there are who go by this name.

And so, also, colour vision research remains a field wherein theories often run widely ahead of facts; wherein the frame of reference of one worker may be entirely different from that of another; wherein predilections and biases sometimes hold sway over concensus and judgment. No person enters the field without some enthusiasm for controversy. And today, the specific areas of greatest contention are, perhaps, the additivity or non-additivity of heterochromatic brightnesses; the role of the opponent-colours in the trichromasy of human colour perception; the differences between small-field and large-field colour mixture functions; the colour perceptions of dichromatic observers; the number of pigments in the dichromatic retina; problems of subjective colour measurement; the nature of anomalous trichromatism; the role of eye-movements; the effects of adaptation; the quantum efficiency of vision; the chemistry photo-reception; and the comparative neurophysiology of colour vision.

It is exciting to see that the 1957 symposium at the National Physical Laboratory covered all these issues; the reported discussions accompanying the papers make particularly stimulating reading.

However, in spite of controversy, the international scene is peaceful. It is not possible to say, for example, that one or another country possesses a monopoly of workers in this field; it has, preeminently, an international body of scientists cooperating in it. In addition to the intrinsic scientific appeal, many practical conse-

quences must be faced, both individually by each country within its own private cultural context, and collectively by the international community due to the increasing amount of world-wide travel and communication. It is essential that the internal industrial standards and procedures of one country should not conflict with or preclude agreement with those of neighbouring nations. It is in this connection, that the present primarily scientific symposium has its industrial relevance, though admittedly indirect and primarily in the future.

Thus, in this symposium, practically every country with active workers in this field is represented, either by papers or by attendance: England as the host country, Canada, Denmark, Finland, France, Germany, Holland, Italy, Japan (though unfortunately only by attendance), Sweden, Switzerland, Spain, the USA, the USSR, and Venezuela. It is possible, as with all such symposia, to think of some work, some individuals or laboratories, left out, but considering the difficulties of planning involved, the present symposium is as free of this objection as any could hope to be. Certainly, the National Physical Laboratory is to be congratulated on the organisation of this important meeting. The already mentioned inclusion of many of the discussions, together with the papers themselves, adds much to one's understanding of the experimental findings and summaries. We can only wish that more such meetings are held in the future. They serve an important function, if only to bring so many vital yet scattered issues together in one place.

The opening paper of the first session was given by Professor George Wald, of Harvard University. It was the Selig Hecht Commemorative Lecture, in memory of Professor Selig Hecht of Columbia, an outstanding American scientist in this field. Wald's lecture is entitled "Retinal Chemistry and the Physiology of Vision," and is his latest summary statement in this area. In its inclusion of much previously unpublished data, combined with a critical survey of the literature, it stands as one of the special contributions of the symposium, and well sets the stage for the later papers.

Wald's paper is followed by additional tributes to the late Professor Hecht, from Professor H. Hartridge, Dr. M. H. Pirenne, and Dr. S. S. Ballard. These then conclude the first session.

The rest of the symposium is divided into five additional sessions: visual pigments, particularly in relation to colour vision; brightness matching and colour matching; subjective colour measurement, temporal effects, defective colour vision; electro-physiological aspects of vision, particularly colour vision; and colour theories. There are 33 papers, in addition to the commemorative lecture, and of course they cannot all be individually discussed. But in order to illustrate in detail some of the more important topics covered, it is probably helpful to list several of the critical papers by title: "The Cone Pigments of the Human Fovea in Colour Blind and Normal"—W. A. H. Rushton; "The Multiplicity of Visual Pigments"—R. A. Morton and G. A. J. Pitt; "The Average Colour-matching Functions for a Large Matching Field"—W. S. Stiles; "An Experimental Investigation of the Relationship between Colour Mixture and Luminous Efficiency"—H. G. Sperling; "Methods of Determination of the Coordinates of Spectrum Colours"—A. Fiorentini and L. Ronchi; "Eye-movements in Relation to Perception of Colour"—R. W. Ditchburn; "A Temporal Factor in Colour Discrimination"—D. Farnsworth; "A Study of Normal and Defective Colour Vision"—M. A. Bouman and P. L. Walraven; "Researches on Dichromatic Vision and the Spectral Sensitivity of the Receptors of Trichromats"—N. D. Nuberg and E. N. Yustova; "Work on the Electroretinogram"—G. S. Brindley; "Beat-frequency Hypothesis of Colour Perception"—D. L. MacAdam; "Variation of Colour Sensation during Adaptation to the Colour Observed"—E. N. Yustova; "Further Development of a Quantified Opponent-colours Theory"—L. M. Hurvich and D. Jameson. This is not to imply that many of the other papers are not of first class scientific value—they certainly are, but I have listed only some highlights.

This is not, of course, a book which one can commend in the usual sense. It is certainly true that at least parts of the symposium must be read carefully by anyone wishing to have expert knowledge in this field. There are, admittedly, some papers of rather minor value, as is probably inevitable with such meetings, and the report reads quite unevenly if read straight through from beginning to end. One must skip and choose with discernment.

Of the issues raised, however, industrial colorists in particular should watch more carefully the future work on adaptation effects, on subjective colour measurements, on large-field colour mixture functions, and on the now evident significant deviations from the additivity of heterochromatic brightnesses. Recent very well publicised work in America, by E. H. Land, for example, on the function of simultaneous contrast in the production of colours by "two-colour" processes instead of the usual "three-colour" processes, can only be placed in its proper perspective by such work on subjective colour measurements—as outlined by W. D. Wright in this symposium. Moreover, the whole area of colorimetry may find itself in great flux, if international agreement can be reached on the problems of large-field standards as based on the completed work of W. S. Stiles. Until then, the developments in this work must be watched with great attention.

THORNE SHIPLEY

New Books

Thermodynamics. By GORDON J. VAN WYLEN. *Wiley, New York; Chapman and Hall, London.* (64*s*)

Professor Van Wylen has aimed his book at students, and attempts "a rigorous treatment of fundamentals, and a distinctly engineering perspective."

Chemistry for Engineers. By EDWARD CARTMELL. *Butterworths Scientific Publications.* (25*s*)

This volume provides an elementary treatment of chemistry as a background study for all branches of engineering science, and is mainly intended for engineering students starting degree or HNC courses.

Nuclear Reactor Materials. By B. R. T. FROST and M. B. MALDRON. *Temple Press.* (12*s* 6*d*)

This monograph, one of a series published in association with the journal *Nuclear Engineering*, aims to provide a broad understanding of the subject for the non-specialist student and engineer.

Annotated Equilibrium Diagrams of some Aluminium Alloy Systems. By H. W. L. PHILLIPS. Institute of Metals Monograph and Report Series No. 25. *The Institute of Metals.* (30*s*)

Diagrams of 20 binary and 12 ternary systems are given, and in each case the published literature has been assessed. The most reliable results are presented together with critical notes and references.

Applied Mechanics: Dynamics. By GEORGE W. HOUSNER and DONALD E. HUDSON. 2nd edition. *Van Nostrand.* (39*s* 6*d*)

The main emphasis of this textbook is on particle and rigid-body dynamics. The intention is to provide students with an understanding of the impact of mechanics on engineering practice.

Electric-Circuit Theory. By F. A. BENSON and D. HARRISON. *Edward Arnold.* (30*s*)

Like many successful textbooks, this is based on the teaching experience of the authors in university engineering courses. Both light and heavy current applications are covered.

Plane Trigonometry. By NATHAN O. NILES. *Wiley, New York; Chapman and Hall, London.* (32*s*)

This text attempts to give a modern flavour to trigonometry, and has an analytic rather than a computational emphasis.

Geology for Engineers. By JOSEPH M. TREFETHEN. 2nd edition. *Van Nostrand.* (64*s*)

A well-illustrated text for the civil engineer, including chapters on geophysical exploration, earth movements, dam sites and reservoirs, and shorelines and their protection.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Plant and Equipment

Mould Dryers. ELECTRICAL RESISTANCE FURNACE CO., LTD., Netherby, Queens Road, Weybridge, Surrey. Details of a range of four portable dryers. Four page illustrated leaflet.

Condenser Tubes. CRANE PACKING LTD., Slough, Buckinghamshire. The Crane process for fixing condenser tubes, described in words and pictures. Booklet.

Ventilators. ROBERTSON THAIN LTD., Ellesmere Port, Cheshire. A ventilator specially designed for the steel, glass and other industries requiring rapid extraction of heat and fumes. It has no moving parts and is available in any length. Leaflet.

Capacity. ADAMS BROTHERS AND BURNLEY LTD., Elmgrove Road, Harrow, Middlesex. Sub-contracting in toolmaking, shearing, gang slitting, presswork, press brake work, sheet metal work, spinnings, welding, profile cutting, buffing, grinding, polishing, plating, bonderizing, parkerizing, painting, and complete assemblies. Illustrated leaflet in colour.

The Reviewers

Mr. J. Mackenzie is deputy to the assistant director of research in respect of process chemistry, refractories and slag utilisation in the research and development department in the United Steel Companies Limited. A fellow of the Institute of Ceramics, he holds an honours B.Sc. in applied chemistry and metallurgy and a Dipl. R.T.C. (metallurgy).

Mr. H. W. Curtis is a member of the Safeguards Division, Health and Safety Branch in the United Kingdom Atomic Energy Authority. During two of his three years in the UKAEA he has been concerned with experimental work on irradiation rigs and irradiated fuel elements, and is now engaged in safety assessments of nuclear reactors. He was previously production manager of Mack Trucks (Britain) Limited. Mr. Curtis is an A.M.I.Mech.E. and an associate of the Institute of Linguists.

Dr. R. B. Hill is a metallurgist in the research and development branch of the Central Electricity Generating Board. He was formerly in the atomic energy division of the General Electric Company and is still mainly concerned with the metallurgical problems of the nuclear power industry. He is an M.Sc., a Ph.D. and a B.Sc.

Dr. Thorne Shipley, assistant professor of physiological optics in the Department of Ophthalmology, University of Miami, is currentley working with the technical optics section of Imperial College, London. He was formerly senior research psychologist at the Research Center of the American Optical Company. He is a member of the American Psychological Association, the Optical Society of America and the Inter-Society Color Council, and holds a Ph.D. in psychology.

The Technical Problems of Broadcasting

Part 3—Linking the Television Network

By J. C. Gallagher
British Broadcasting Corporation

Microwave radio links are an essential part of the main television broadcast network. They enable good quality picture signals to be transmitted over long distances.

The transmission of television pictures presents special problems, compared with the transmission of sound, because of the much greater bandwidth required and the high standard that has to be achieved in the technical characteristics of the system. Satisfactory sound quality for broadcasting can be achieved by transmitting a band-width of about 8,000 c/s, whereas the 405-line television system used in this country requires a band-width of 3 Mc/s—more than 300 times as wide as that needed for sound. The transmission of such a wide band of frequencies over long distances necessitates the use either of special coaxial cables or of wide-band radio links.

The permanent network connecting the BBC's studio centres with the transmitting stations in various parts of the country comprises circuits rented from the Post Office, some in coaxial cable and others in the form of a series of point-to-point radio links. In addition, temporary links are frequently required for outside broadcasts which contribute some 18 per cent of the output of the BBC television service and include public events, sport, documentary programmes, entertainment, and news items. To transmit the picture component in these programmes from the source to a point from which they can be distributed over the permanent network, it is usually necessary to use mobile radio links; where the camera itself has to be mobile, a radio link is the only possible one. For connecting a fixed outside broadcast point with the main network, one or more microwave links are usually necessary. (The term " microwave " is loosely used to refer to wavelengths of less than 30 cm., i.e. frequencies higher than 1,000 Mc/s.)

The frequencies used by the BBC for such links are in the SHF range and are between 4,400 and 4,800 Mc/s and between 7,050 and 7,125 Mc/s; corresponding to wavelengths of about 6 cm and 4 cm respectively. The use of these bands for television links has the following advantages: (*a*) the ratio of the base-band frequency to the carrier frequency is small, (*b*) there is a complete freedom from noise generated by electrical and magnetic disturbances, and (*c*) there is little likelihood of interference from other signals in the same band because of the highly directional properties of the transmitting and receiving aerials.

Since a radio link has only to transmit from one point to another, it is possible to use transmitting aerials that concentrate the energy into a narrow beam and so give a high gain in signal strength as compared with an omni-directional aerial. The same applies to the sensitivity of the receiving aerial. For example, an aerial with a paraboloid reflector having a diameter of about 4 ft has a power gain of 5,000 times at 7,000 Mc/s as compared with a simple omni-directional aerial. Thus a transmitter with an output power of 1 watt feeding such an aerial system would give an effective power in the required direction equivalent to 5 kW, feeding a simple aerial. A similar gain can be achieved at the receiving end so that there is a total power gain of $2{\cdot}5 \times 10^6$ as compared with a simple aerial system at both terminals.

Paraboloid aerial assemblies for an installation of this type are shown in Fig. 3. The radiating element is focused accurately in relation to the paraboloid and the beam width is only $\pm 2^\circ$ (to the half-power point). There are also side lobes, displaced on either side of the main beam, but these are greatly attenuated in amplitude and displaced some way from the centre of the main axis, so they are of little significance. The valve used to generate the microwave frequency is generally a reflex klystron, or similar type, where the reflector or resonator is frequency-modulated with the video signal derived from the television camera at the source. The frequency-modulated centimetric signals are then transmitted to the receiving terminal of the link.

At frequencies below a few megacycles per second physical obstructions such as buildings have little effect on radio transmission because the size of the obstacle is usually small compared with the wavelength of the signal. As the frequency increases, the wavelength decreases in proportion until a condition is reached where the losses absorb most of the energy radiated. At frequencies above about 300 Mc/s the path between the transmitter and the receiver must be unobstructed and high aerials must therefore be used either for transmission or for reception, or both. The behaviour of waves at these frequencies may often be treated in the same way as that of beams of light and the analysis accordingly yields to optical geometry.

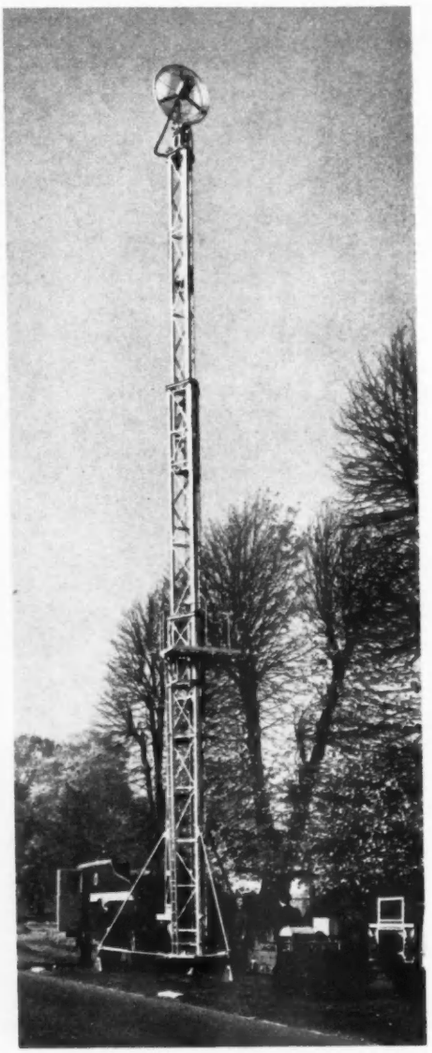


Fig. 1 Special radio link vehicles can be set up wherever required. They carry extendable masts on which a paraboloid aerial can be mounted at 60 ft from the ground.

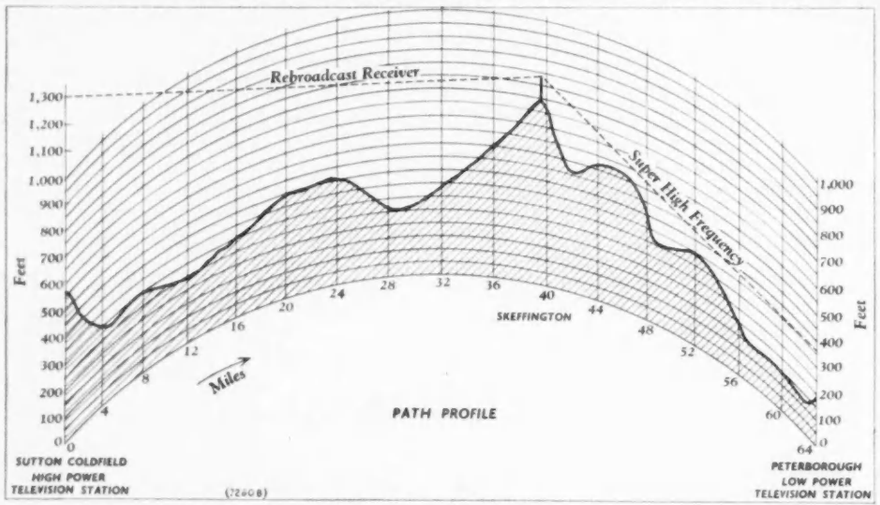


Fig. 2 Path profile shows a signal pick-up of the television transmission at Sutton Coldfield on a rebroadcast receiver specially designed for the purpose. At Skefington, the signal imparted to the SHF link equipment for onward transmission to Peterborough is derived from this receive

Microwave signals transmitted over a path between two parabolic aerial systems may be assumed to travel from the transmitter terminal to the receiver terminal in the form of a beam similar to that provided by a light source, the width and intensity of the signal being dependent to an extent on the size and shape of the reflector which directs and receives the source of energy. The zone of maximum energy is centred in the middle of the beam within which is a region designated the first Fresnel zone; this may be defined as the elliptical boundary from which any reflected signal will travel an additional half wavelength between the transmitting and receiving paraboloids. Because of this the reflected

signal will arrive as an aiding signal with a tendency to reinforce the direct signal. If the Fresnel zone becomes penetrated by an obstruction even though line of sight clearance may exist, reflections from this obstacle will not have the half wavelength of travel required and may arrive at the receiver terminal in a random fashion producing a partially or totally cancelling signal.

Centimetric signals are refracted by atmospheric changes in the transmission medium and suffer attenuation because of the dielectric density of the atmosphere near the earth's surface. Changes in the refractive index of the atmosphere result in bending of the rays, so that both direct and reflected waves may arrive at the receiver. In the case of paths over water and over flat countryside the reflections may give rise to fading because of an unfavourable phase relationship of the wave fronts. This phenomenon is of considerable importance in the engineering of circuits across large water masses, and a margin to compensate for the resultant fading is usually taken into account in planning the system.

In planning microwave relay systems it is essentially not only to have full fresnel clearance between both terminals, but also to ensure that the distance between these sites is such that the total loss in the transmission path is less than the total gain of the relay system by a margin that takes into account all the losses of the system, including fading. It is possible to predict and to calculate with reasonable accuracy all the factors influencing the behaviour of a circuit between any two points, provided free-space transmission is achieved, and to set down the parameters which the link equipment must meet to offset all the transmission losses. A path profile of a typical microwave linkage is shown in Fig. 2.

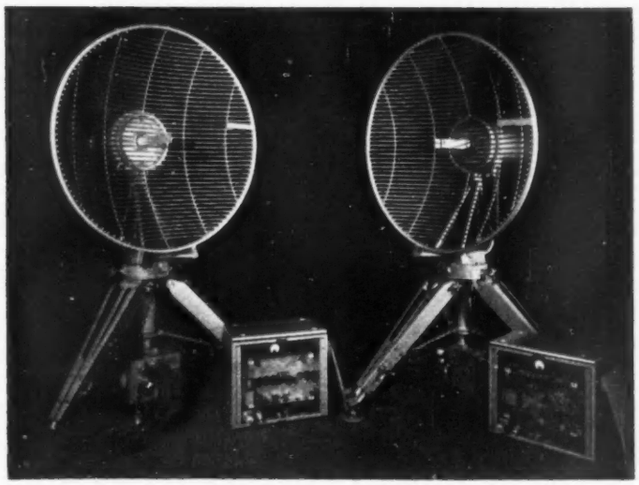


Fig. 3 (below) Transportable link equipment, type EMI ML6C. The paraboloid aerials are able to concentrate the radio energy into a narrow beam, so giving a very high gain compared with ordinary, non-directional aerials.

For reasons previously stated, the BBC television transmitting stations are sited on high ground within the area they serve and in many cases the masts that support the transmitting aerials are some 750 ft high. At Holme Moss, for example, the site height is 1,720 ft above sea level and the height of the transmitter aerial 730 ft above this. The optical horizon thus extends over a wide area and advantage has been taken of this to install specially-designed microwave receivers on the masts at all BBC high-power and medium-power television stations. Because these receivers are mounted so high on the masts, they are inaccessible for a large proportion of the time, especially in winter; they must therefore be operated by remote control from the ground. The paraboloids, which have a diameter of 4 ft, are mounted on opposite faces of the mast and can be traversed by special slewing units, which permit them to be set to, and maintained on, any bearing within their traverse to an accuracy of $\pm\frac{1}{2}°$. As the sweep angle of each paraboloid is 270° there is a reasonable overlap on the total coverage of 360°.

Either paraboloid may be connected to two sets of microwave receiver equipments, part of each being mounted at high level on the mast and part in the main transmitter building. The essential units of the receiving equipment are sealed in weatherproof cubicles, and elaborate precautions have been taken in the design to ensure that the units at the mast head operate reliably for long periods without attention. Magslip indicators mounted on the control bay show the position of the paraboloids and of the local oscillator cavities. Provision is also made for metering the essential voltages and currents, and for switching to reserve circuits if a fault occurs on one of the mast-head units.

In the case of portable link equipment the signal is demodulated to video-frequency before passing onwards to other links or to the television distribution network. Sometimes it is possible to transmit from the outside-broadcast point directly into the mast-head receivers at the main transmitting station and thence into the network. Other occasions require a number of intermediate points in tandem before the main network is reached. For example, Her Majesty's Christmas television broadcasts from Sandringham need four relay points to convey the signals from Sandringham to Sutton Coldfield for nation-wide distribution.

The ancillary equipment and vehicles necessary to set up a television outside broadcast network are comprehensive and versatile. Most of the apparatus was developed to meet requirements as they arose; an interesting example of this is the design of a telescopic mast which extends to a height of 60 ft, on the top of which a 4 ft paraboloid can be fitted, as shown in Fig. 1. The position of the paraboloid can be set by remote control from ground level. The mast is made of extruded alloy and built in three sections, carried on a four-wheel-drive vehicle. Both erection and elevation are controlled by hydraulic rams and the torsional stability is better than $\pm\frac{1}{2}°$ when the mast is fully extended and unstayed.

Specially equipped radio-link vehicles have also been developed in the form of self-contained mobile stations which accommodate the operating staff and all the equipment necessary for an intermediate point, or for the starting point, of an outside broadcast. These vehicles tow mobile generators giving an output of about 6 kVA and are thus independent of public electricity supplies.

The latest type of radio-link vehicle (Fig. 4), which was developed to meet the special requirements of the BBC television service, was first used some months ago; 16 similar vehicles are now in use. The body is built on a 3 ton Austin long wheelbase chassis; the overall length is 18 ft 10 in and the width 7 ft 6 in; the floor to ceiling height is 6 ft 6 in. The roof platform has been arranged to accommodate to 4 ft SHF paraboloids and tripods, together with aerials for sound and communication purposes.

Fig. 4 (above) The latest BBC microwave radio link vehicle has been developed specially to meet their requirements.

Lockers which are specially equipped for stowing this gear as well as cables, etc., are provided and access is obtained from outside the vehicle. Stabilising and load-carrying jacks are integral with the chassis. The interior is fitted with racks, cupboards, workbench and control table for carrying the miscellaneous equipment required for a television outside broadcast radio link. Wiring is built into the bodywork and special fixing and shockproof mounts used.

The equipment can either be operated in the vehicle or demounted and put into carrying cases for use elsewhere. Special attention has been paid to ventilation, and weatherproof extract fans are included in the bodywork. As engineering staff may have to spend long periods in remote places on duty in these vehicles, considerable attention has been given to reducing discomfort to a minimum.

In addition to the SHF equipment used for the vision signals, UHF radio links are also used for telephone communications to provide contact between vehicles set up in remote places and their base.

Parts 1 and 2 of this series appeared in the issues 1 January and 15 January, respectively. Two more parts will follow at short intervals.

High Speed Feed for Hydraulic Press

When the Norton 7½-ton Super-Speed hydraulic press was developed just over a year ago (ENGNG., p. 198, 13 Feb. '59) there seemed to be no practical way of feeding strip fast enough to utilise the maximum speeds of the press. Now, after some intensive development work, Norton have produced a roll feed unit which enables the press to be worked at speeds of up to 850 strokes per minute (s.p.m.). Available as a feed-in or feed-out, or as a double roll tandem unit, it is able to cope with the full range of automatic stroking speeds of the Norton Super-Speed press (40 to 850 s.p.m.). It is also suitable for any length of progression and is readily adjustable for any normal weight and gauge of materials.

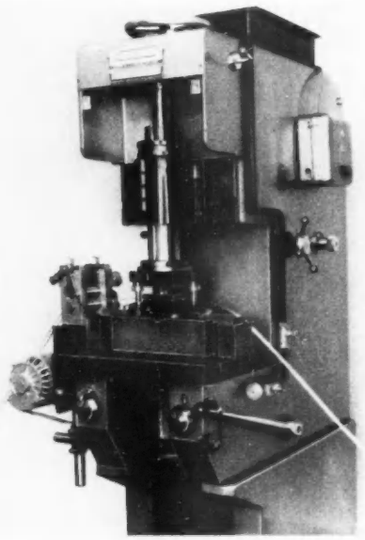
To achieve these characteristics the designers have followed somewhat unconventional lines, recognising that with most methods of feeding where the progression is set in the feeder, the actual progression obtained in operation may vary considerably with the linear speed and weight of the strip material and the stroking speed of the press; particularly when the latter reaches the unusually high level of 850 s.h.p. The Norton feeder therefore presupposes that the progression or indexing is built accurately into the press tool by means, for example, of a trigger stop or side crop and provides conditions in which such accuracy can be used to full advantage.

These conditions are instantaneous pick-up and sensitive control of forward torque, so that the latter is high for progressing the strip but is low at the moment when the strip is held by the stop or side crop in the tool. They are achieved by a simple belt drive from a fractional horsepower motor to the bottom of a pair of hardened steel rollers; with provision in the drive arrangement for adjusting first the overall torque, second the amount of torque transmitted when the strip is at rest, and third, the relation between the latter and the progression torque. Thus, the torque transmitted when the strip movement is checked by the tool can be set so light as to ensure no tearing of low tensile, thin gauge material against stops, and to allow ready alignment of pilots, while still maintaining adequate progression torque for instantaneous pick-up on release of the strip.

Since the strip is always under control, high speeds can be maintained on thin gauge material without strip flutter. The top roller is also adjustably spring loaded and a two-diameter reversible pulley is fitted to the motor to give a choice of two roller speeds. The whole unit is mounted on the side of the press and is adjustable both vertically and horizontally.

The Norton roll feed is also well suited for feeding short lengths of strip, since when it is set as a feed-out unit each length runs right through, completely clearing the tool ready for the next operation. In addition, operation and progression are almost unaffected by defects in the strip in the form of kinks or burrs.

The units are easily mounted, set and dismounted on the Norton press. Consequently setting times, even for relatively short runs, are economical and operation of the press may be readily changed from high speed production to development or general purpose work.



Developed just over a year ago, the Norton high speed press was capable of more than 1,000 s.p.m. Now a newly developed feed mechanism enables much greater use of these very high speeds.

Mass Spectrometer for Heavy Atomic Nuclei

One of the world's largest, most complex and most precise instruments for determining the relative amounts and weights of atoms and for measuring the infinitesimal energies that hold atomic nuclei together, has been developed and built at the Argonne National Laboratory, Lemont, Illinois, USA. The instrument, which weighs 40 tons, is known as a double-focusing mass spectrometer, because it incorporates both velocity and direction focusing.

Said to have 100 times the sensitivity (for heavy element atoms) and 10 times the resolution of smaller mass spectrometers, the new instrument has been described as "an imposing addition to the analytical apparatus of nuclear chemistry." The radius is 100 in, giving the instrument a total length of 40 ft. It is 6 ft high and cost a total of $381,000 to develop and build.

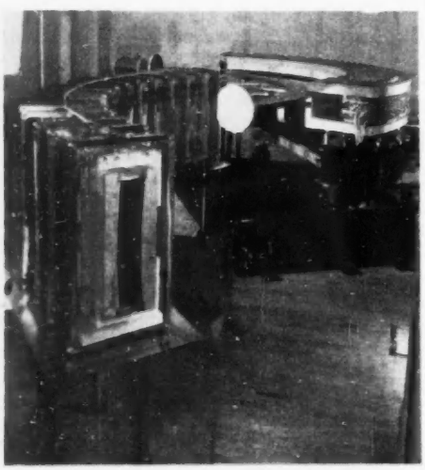
A variety of experimental problems, requiring both high sensitivity and high resolution, will be studied with the new instrument at Argonne. Among these will be: analysis of the isotopic composition of the very small amount of uranium in a meteorite sample, for comparison with the isotropic composition of uranium from the earth; a search for natural curium-247, which is an isotope found only in the debris of nuclear explosions; a more accurate absolute measurement of the half-life of caesium-137, which is also fission a product.

Another analytical application of the new mass spectrometer will be the determination of the types of atomic nuclei that are created when target atoms are bombarded by high energy particles from an accelerator. For this application the spectrometer will be used in conjunction with the zero gradient proton synchrotron (zgs) now being built at Argonne.

The apparatus consists of four principal parts: the source unit, where atoms are charged and accelerated into the machine; the electrostatic analyser, where velocity differences of the charged atomic nuclei are compensated for; the magnetic analyser, where the nuclei are sorted according to weight; and the collector unit, where the ions are detected.

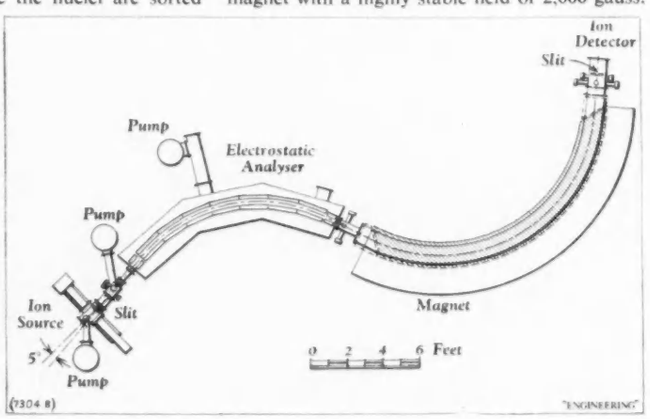
The entire spectrometer has an unusually large aperture, that is to say that the transmission of ions from the source unit and the resolution of ions at the collector are both high. The instrument is designed to transmit more than 95 per cent of the ions produced, with a resolution of 10,000. A high vacuum (10^{-6} mm Hg) is maintained throughout the mass spectrometer to allow unrestricted motion of the ions. By maintaining high standards of cleanliness it has been found that this degree of vacuum can be achieved without resort to baking the assembly.

In the source unit the ions pass through electron lenses which define the width of the beam and its angle of divergence in two directions. On leaving the source unit the ions pass into the electrostatic analyser. This is a 75° angle portion of a spherical condenser with 100 in radius. It is composed of seven sections made of fused quartz, weighing a total of 1 ton. The magnetic analyser is a 14 ton permanent magnet with a highly stable field of 2,000 gauss.



(Left) Double-focus mass spectrometer, 100 in in radius, with vacuum tank removed. The electrostatic analyser can be seen in the foreground.

(Right) The new instrument is said to be double focusing because it differentiates atomic nuclei by both direction and velocity.



Marketing

Exhibitions and Orders

The Russian trade delegation in Britain has ordered sixteen gas-liquid chromatographic analysis apparatus, worth £16,000, from GRIFFIN AND GEORGE, of Alperton, London.

Scientific representatives of the Soviet delegation saw demonstrations both at the company's headquarters and at the symposium of micro-chemistry held in Birmingham last year. This is Griffin and George's second order from the USSR.

Over a broader range, British scientific instruments are to be shown in Moscow from 16 to 26 June this year. The decision to hold this, the first specialised British manufacturers' exhibition in Moscow, was taken after the three-man delegation of the Scientific Instrument Manufacturers' Association had visited Moscow and reported back. The show will be supported by at least thirty SIMA members.

Expansion in Automation

ELLIOTT-AUTOMATION, already the largest control valve manufacturer in Europe, has enlarged its interests with the purchase of BLACK AUTOMATIC CONTROLS, of Corsham, Wilts.

The Elliott-Automation group includes 25 companies in the automation field, four of them, counting Black Automatic Controls, producing control valves. One of these, the FISHER GOVERNOR company, has recently begun to function in Australia. Another, JAMES GORDON VALVES, has the contract for the "Pilgrim" ballast valves for the new P & O liner "Canberra."

The acquisition of Black Automatic Controls will strengthen the Elliott group's connection with the gas and chemicals industries.

Onia-Gegi in Japan

A gas from oil plant which will be the largest of its kind in the world is to be installed in Japan by HUMPHREYS & GLASGOW.

The total cost of the installation is to be £700,000 and by the end of this year four units, each producing 5,000,000 cu. ft of town gas a day will be operating. The eventual capacity of the plant, at Osaka, will be 30,000,000 cu. ft a day.

Humphreys & Glasgow will be putting in their Onia-Gegi process by which town gas is made from heavy fuel oil and other hydrocarbons. The company are to cooperate closely with the ISHII IRON WORKS and the OKURA TRADING company. The Osaka plant will be the third Onia-Gegi installation in Japan, but the first two, now in use at Yaizu and Himeji, are very much smaller.

Turkish Oil Refinery

Two British oil companies have a 44 per cent interest in building an £18 million oil refinery in Turkey. Mr. Menderes, the Turkish prime minister, has already laid the foundation stone, eight miles from the southern Turkish port of Mersin. The refinery, to be completed by mid-1961, will have a processing capacity of 3,200,000 metric tons a year. While not in the Abadan class it will still be one of the largest in the Middle East.

The contract has been awarded to the FOSTER WHEELER CORPORATION, of the United States, and three western oil companies will build the refinery. They are:

BRITISH PETROLEUM,
SHELL, and
SOCONY-MOBIL OIL.

The capital participation is to be Socony 56 per cent, Shell 27 per cent and British Petroleum, 17 per cent.

Property Owning (American) Democracy

Close behind the Press of the United States for speed of communication comes the celebrated firm of brokers and investment advisers, Merrill Lynch.

Their full title is MERRILL LYNCH, PIERCE, FENNER AND SMITH, which came about by the merger of three Stock Exchange firms in 1940-41. With four billion securities held in the company's vaults for tens of thousands of customers Merrill Lynch maintain a systematic investigation of the industries and trade of the United States that few of the agencies of public information can match.

Fashionable at the moment, with the rapid appreciation of Stock Exchange prices on Wall Street and Throgmorton Street, is the advice not to invest unless you are also able to save against emergencies. "There is an element of risk in security ownership," says one of the Merrill Lynch publications. They go on to point out that since it can depreciate there is a risk in having any money at all.

Describing themselves as "ethical brokers," Merrill Lynch make the important point that stocks have to be paid for within four days of being bought. This is the bulwark of the defence against another run away in stock prices on the 1920's pattern.

The selling to the public in the west of the idea of having a "share" stake in the economy necessarily raises the level of demand for the available goods. Evidently they are not now being bought on borrowed money, or at least, not money borrowed from the brokers.

The prospective levels of prosperity expected from the 1960's look likely to see such stock quotations and demands on the services of firms like Merrill Lynch, that it would be highly unsafe to set upper and lower limits.

Farthings and Cash Ranks

GENERAL TRADE EQUIPMENT received some very odd replies when they advertised recently for farthings. They did not get as many as they would have liked but they did have a telephone call from one hopeful who asked the company to keep watch for a special 1911 farthing which he needed to complete his collection.

All these farthings are not just modesty. General Trade Equipment wish to demonstrate their new bench type weighing machine and to do so they wanted 250,000 farthings. Banks told them that they had none. The Royal Mint has not issued any since 1956.

Another idea from the same company is a new lightweight cash rank which stacks coins from a half-penny to a half-crown. By reducing the risk of wrong change and, so it is claimed, halving the time a cashier takes in giving change, the cash rank should save everybody's time.

The series of troughs of the rank are so arranged that each coin dropped into it will find its own graduated slot automatically.

More Productivity Less Coal

It is one of the unfortunate ironies of the coal situation that just as the industry is producing the best output per manshift improvements seen in 30 years it is less output and not more that is wanted. Sir James Bowman, chairman of the NATIONAL COAL BOARD, has now announced the steps by which 1960's production is to be reduced to 188 million tons of deep mined coal. This is less than the 195 million tons of last year and much less than the 201 millions of 1958.

But what matters to the Board's finances is that it is also less than the expected consumption of 196 million tons in 1960, which means that some of the extremely costly coal stocks should be used up. The reduction in opencast production will be by some four million tons. Another four to five millions will be cut as the result of taking out of use 46 collieries most of which are within sight of the working out of their economically useful coal.

There is no doubt that the Board have handled the melancholy business of getting down the output, and the numbers employed in the industry, without setting up the acute poverty of the coal mining areas in the late '20s and the '30s. That this could only have been done with a nationalised corporation's power to run in the red with a debt accumulating stock pile of 50 million tons is as obvious as would have been the political repercussions of returning to the former social conditions.

The improvement in output per face-worker per manshift in 1959 was 6 per cent. This was largely responsible for the drop of 1*s* 9*d* a ton from the 1958 level in production costs. And it goes a long way to support Sir James Bowman's contention, as chairman of the Board, that so long as foreign dumping of oil is not allowed British coal, from a streamlined industry, holding its prices as it has done for two and a half years, has a competitive role to play in industry.

£30 Million Stop Gap Plan for Steel

The STEEL COMPANY OF WALES plans to spend £30 million on increasing sheet steel supplies before the first of two new strip mills, SCoW's own and RICHARD THOMAS and BALDWIN's come into production in 1961 and 62.

SCoW is now in the middle of developments costing £52 million and when the new capacity is operational, in mid-1962, the company's output potential will be 3 million ingot steel tons a year, plus the output from the £30 million scheme which will mean a total of 3,650,000 tons. The increase is to be obtained by modifications of existing plant.

The scheme also includes the creation of a 48 in hot strip mill standing alongside the existing 80 in hot strip mill. More sheet finishing equipment is to be installed and by using the 48 in mill for steel coil for such purposes as tinplate, the 80 in mill will be able to roll extra sheet for the motor industry.

The latest information on the proposed Steel Company of Wales £30 million scheme is that the iron and steel authorities are giving the plan detailed consideration and an announcement is expected.

£4 Million in Steelworks Contracts

RICHARD THOMAS AND BALDWINS have gone to LURGI APPARATEBAU-GESELLSCHAFT for the sinter plant for their Spencer steelworks being built outside Newport, Monmouthshire.

Most of the equipment in the £2 million contract will be made in Britain to Lurgi specification. JAMES HOWDEN will be the principal United Kingdom firm concerned—they have a recent agreement with Lurgi.

A second £2 million contract has been awarded to MITCHELL ENGINEERING's mechanical handling department. It covers coal and ore screening, crushing and conveying machinery and storage plant. The Lurgi sinter plant is expected to be working by September of next year. The mechanical handling contract is due to be completed by March the same year.

Another Record Spending Year

All the available figures point to 1959 having been another point on the upward graph of consumer spending.

The third quarter's figures are now released and they show that at £3,871 million, consumer expenditure had perceptibly risen above the comparable 1958 level—£3,735 million.

The budget beer-gift may have stimulated demand but not enough to prevent the money spent in the quarter dropping about 0·75 per cent. On food, tobacco, cars, motor cycles, housing and clothing more was spent—the largest increase being £31 million more on food.

The average weekly food expenditure in Britain during 1959's *second* quarter was 29*s* 6*d* per head, 6*d* more than the year before.

Export Generator in Quick Time

Within two months of receiving a rush order from the Argentine, MIRRLEES, BICKERTON AND DAY, a company of the HAWKER SIDDELEY group, built and delivered to the ship a 2,200 kW alternator set driven by a Mirrlees KVSS-12 V-form 12 cylinder diesel engine. Complementary equipment, spare parts and ancillary pipework were also produced.

The order, received through the company's agents in the Argentine, Buxton Limited, stipulated that in order to comply with the import permit the equipment should be in Buenos Aires before the end of the year. In fact the alternator, switchgear and transformers and all the rest of the material was at sea before the beginning of December.

The generating equipment is for a large Buenos Aires cotton mill.

Reeling Made Safer By Automatic Feeding

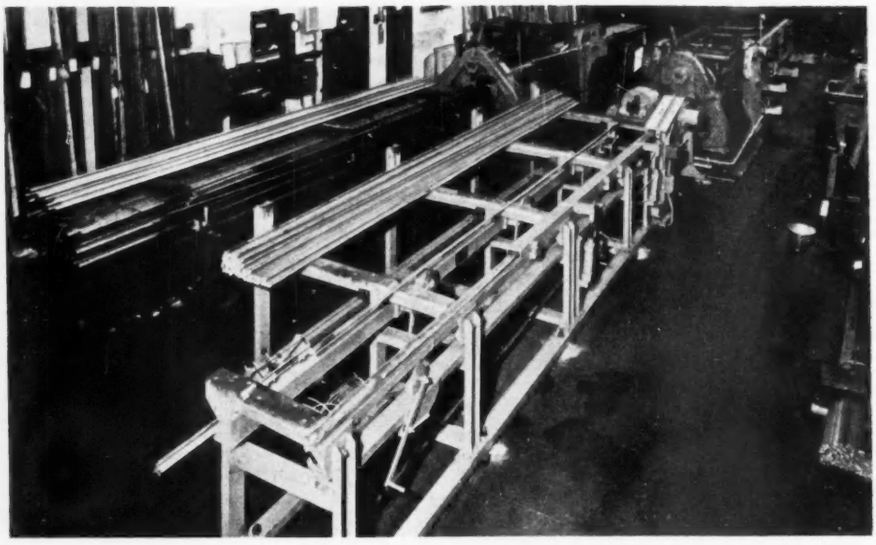
Factory inspectors have long regarded the reeling process as one of the more dangerous in engineering, and it has also been the subject of a book issued by the British Iron and Steel Federation. New semi-automatic bar feeding and handling equipment recently installed in the works of Pratt, Levick and Company Limited at Chester is reported to have changed all this and eliminated almost all of the hazards from the work.

The equipment, which was designed and manufactured by the automation division of the Hymatic Engineering Company Limited of Redditch, feeds round bars of $\frac{1}{8}$ in to $1\frac{1}{2}$ in diameter to a reeling machine, and extracts and ejects reeled bars from the output end of the machine. Whipping of the bars during the reeling process which is one of the greatest dangers in any bar preparation process, is now completely eliminated. Full interlock protection is incorporated in the pneumatic and electrical circuits giving added protection to both operator and equipment.

Only one semi-skilled feeder is needed to control the equipment, instead of two or three previously employed, and a very heavy manual job has been reduced to a relatively light operation. As the equipment handles the bars automatically, the feeder can start preparing the next bar as soon as the first has entered the rollers. This gives the machine a much higher utilisation factor.

The equipment can handle a 2 ton load of bars, which is deposited on separate rails by an overhead crane. The feeder then selects a bar and rolls it part-way down a set of inclined rails until it rests in a set of V-notches in the rails. A set of freely running V-rollers then lifts the bar to the height of a chamfering machine head. The feeder pushes the bar forward into the chamfering machine, where it is automatically gripped and machined. When the bar is released, the feeder withdraws it, lowers the V-rollers and rolls the bar down a short length of inclined rail until it falls into open clapper boxes. These are, in effect, tunnels formed by lengths of channel iron, one on top of the other, with their open sides facing one another. Hardwood lingings are fitted into all the clapper boxes. The feeder then closes the clapper boxes by means of a pneumatic control valve and, similarly, causes a pair of pinch-rollers located at the forward end of the equipment, to grip the bar and feed it forward into the reeling rolls. An automatic device is fitted which retracts the pinch-rollers just before the bar is engaged by the rollers.

On leaving the rolls on the exit side, the bar enters another series of clapper boxes which prevent it from whipping. As the trailing end of the bar leaves the reeling machine, a further pair of pinch-rollers automatically withdraw it clear of the working area. These rollers then open and the clapper boxes open to release the bar. Opening the clapper box also raises a set of inclined ejection rails, which are situated at intervals along the clapper boxes. These rails lift the finished bar clear of the boxes and allow it to roll down onto a transit stillage.



At the far end of the input of the bar feeding equipment is the heading machine which is slightly in advance of the bar reeling machine. The reeling machine has wire guards surrounding it. Beyond this machine is the bar ejection system.

Defects in Welds

At a recent meeting of the Society of Non-Destructive Examination, Dr. Richard Weck, director of the British Welding Research Association, spoke on the significance of defects in welds. Dr. Weck began by emphasising that this was a most complex question to which he could not be expected to give a simple answer. The subject was incompletely understood and there was a need for a lot of work of a fundamental nature and for much more data on service failures. The British Welding Research Association was active in both directions but its present resources were rather inadequate for the task facing them.

It was necessary to differentiate between defects in welds in constructions subject only to static loading and those in structures subject to repeated or fatigue loading. The effect of a defect was two-fold. Depending on its size, it reduced the cross-sectional area producing a slight increase in the average or nominal stress. This effect could generally be entirely ignored under all loading conditions, unless the defect was very large in extent and produced a very considerable reduction in cross sectional area. The second, much more important, effect of a defect was the production of concentrations of stress. Even this effect might be unimportant under static loading conditions, provided the material was in a sufficiently ductile condition to reduce the effect of stress concentrations, by undergoing plastic deformation. When, however, a material was used below its transition temperature and, if in addition, residual welding stresses were present, defects played a very important role in the initiation of brittle fracture.

Under conditions of fatigue loading the position was very different. The very high stress concentrations produced by defects might result in the production of premature fatigue cracks, with the possibility of early failure. However, even in this case, he did not believe that small, isolated pockets of porosity would have much effect, and he considered that it was often a mistake to cut out such defects. Sharp corners might be introduced into the weld and be left in it after the "repair" had been completed. Such discontinuities had been shown to be capable of doing more damage than the defects which had been removed.

Sometimes many of the worst defects were those in the surface which could be seen with the unaided eye. Small internal defects which could only be revealed by elaborate and costly methods of non-destructive testing were probably the least important.

Dr. Weck declared that he was not unduly worried about the possibility of failures occurring in butt welds in pressure vessels, but he felt there was some cause for concern about failures occurring in welds joining stand pipes to pressure vessels. Such welds were harder to make and very difficult to inspect properly. Coupled with this, they were subject to much higher stress concentrations.

It was often considered desirable to heat treat welds to remove much of the residual stress. However, he was not sure that this was always beneficial. Evidence had recently become available which appeared to suggest that if a defect was present at a place where there was a residual compressive stress, then the structure would be much safer in service if the compressive stress were not removed. In the case of a tensile stress associated with a defect, the evidence still pointed to the need to remove this stress. The general problem was, therefore, rather complex and it would depend upon the circumstances whether heat-treatment was detrimental or beneficial.

The speaker referred to a case when the weld contour had played a more important part in determining the strength of a weld under fatigue than defects. It had been found that on comparing welds made by an automatic process with those made by manual welding that the latter had appeared to be much stronger than the former. The explanation of this was found to be that the hand welding produced a smoother contour between weld and parent metal than the automatic process, where the angle tended to be almost acute.

On the subject of acceptance codes, either in the form of diagrams or radiographs, Dr. Weck declared himself completely opposed to their use. There was not enough basic information available to permit such codes to be devised. So much depended upon particular conditions that it was not to be expected that useful guidance could be given by codes based merely on empirical considerations. No code could be a substitute for a properly educated inspection engineer. This engineer should have a wide background of practical experience in design as well as inspection.

Automatic Control Simulator

A new analogue computer is being used by the British Petroleum Company's refineries and technical department to aid the study of systems for the automatic control of the oil production and refining processes. The new equipment, named CERES (control engineering research electronic simulator), was built to BP Engineering Division specification and installed in Longbow House, one of BP's buildings in London.

The company consider that automatic control is becoming increasingly important in both the production and refining of petroleum. CERES is being used to reproduce or simulate conditions in various fields of oil production and refining operations, so that the most suitable automatic control systems for efficient plant designs can be studied and developed.

The simulator is also to be used to investigate such problems as plant economics, stress and vibration analysis, and the best methods of training plant operators in the handling of automatically controlled processes.

Plastics Solve Production Problem

Two important aspects of reinforced resin structures are low tooling costs and ease of moulding. An illustration of their usefulness in this respect was reported recently from the Chertsey factory of B.K.S. Limited, when the company were asked to supply their 30A 4-pole contactors with covers made in an insulating material instead of sheet metal. The time factor allowed for this conversion was only four weeks.

Although it was resolved that the final answer to the problem would be to make the covers in a phenolic moulding material, this could not be done in the short time available because of the lengthy process of making the necessary tools. Reinforced resin covers were therefore decided upon as an interim measure. These covers were designed and made from Bakelite polyester resin

Fixing Bakelite polyester resin covers.

by the moulding division of Coin Insulation Limited of Woking, Surrey. Wooden moulds, which are of course very much cheaper than metal, are used in the fabrication of the component.

Forge Modernisation

The British Iron and Steel Federation have published the full proceedings of the conference on the modernisation of forges which they organised in September, 1958. The full texts of the papers delivered at the conference together with the subsequent discussions is included in the proceedings, which consists of 31 pages illustrated by photographs and diagrams.

Under the chairmanship of Mr. F. J. Somers, three papers were delivered to the conference. They were " Building a New Forge," " Features that Make for a Well Designed Modern Forge," and lastly, " A Method for Comparing Alternative Ways of Forging."

Guided Electric Trucks

The accompanying illustration shows a part of a production line at Hayes, on which EMI Electronics Limited fit electronic guidance systems to battery operated trucks. The trolleys, called Robotugs, have control units into which an operator can programme the necessary instructions to make the trolley call at up to 75 different points for loading or unloading. Arrangements can be made to call at more points if desired. When restarted at the last of these, the trolley automatically returns to its original destination.

The guidance system operates by making a

The EMI electronic guidance system being fitted to Conveyancer electric trucks.

trolley follow a single wire which can be taped to the surface of the ground for very short term use or buried below the surface for permanent installations. Several trucks can be operated simultaneously on the same network, and a block track system, similar in principle to the London Underground signalling system, ensures that there is always a " dead " section of wire between any two trolleys.

Experiments with Robotugs, which are reported to combine the merits of a conveyor belt system and manually driven trucks at a fraction of the cost, have been going on at the Newton Abbot railway goods shed for the past nine months.

Beet Sugar Plant

A contract for the supply of two complete beet sugar factories for the USSR was signed in London on 29 December by representatives of Techmashmiport of Moscow and by Vickers and Bookers Limited, the joint company recently formed for developing sales and supply of machinery for beet sugar factories to the USSR, China and other Eastern European and Far Eastern countries. This order follows a contract secured earlier in the same month by the same company for equipment for the Soviet Union.

The new order calls for the supply of two factories, one in the Moscow region and the other in the Ukraine. Each of the two factories is to have a daily capacity of 5,000 tons of beet.

Oxygen Steelmaking Plant

The new steelmaking plant to be installed by the Consett Iron Company as part of their current development plan will be the first plant in the

Head Wrightson's experimental L.D. converter.

world to use both the L.D. and the Kaldo oxygen steelmaking processes. Head Wrightson Iron and Steel Works Engineering, a subsidiary of Head Wrightson and Company Limited are to build two 100 ton L.D. units and two 100 ton Kaldo units for the company. The new plant is expected to go into production at the end of 1961 and is designed to produce an annual output of about 750,000 tons.

After studying all the available steelmaking processes and carrying out extensive tests, the Consett Iron Company decided to adopt both processes in order to cover their range of products effectively. The L.D. process is especially suitable for the production of steels in the low carbon range, while the characteristics of the Kaldo process enable a very wide variety of analyses to be produced.

Head Wrightson have been engaged for some time in research and development work on oxygen steelmaking processes and the associated problems of gas cleaning. This work has been greatly facilitated by the use of an experimental L.D. convertor in their works at Stockton-on-Tees and by visits to similar plants on the continent and in the USA.

Gear Hobs Restandardised

In order to fit in with changing conditions the British Standard on gear hobs has been replanned. Part I of the revision has just been published as BS2062 : 1959. It covers hobs for general purposes from 1 DP to 20 DP inclusive. In drafting the Standard, account was taken of the recent work done by the International Standards Organisation and also of the current American specifications. The tooth form and pitches given are in agreement with ISO recommendations Nos. R53 and 54.

A new high grade of hob has been included which is comparable in accuracy with the grade AA for marine hobs. Hobs of this grade have been found necessary when cutting gears to the fine limits required in some modern specifications. Limiting parallel arbor dimensions are recommended in an appendix, so that correct fitting conditions between hob and arbor can be obtained.

The presentation of the tables of permissible errors shows typical methods of test for each element. This presentation is similar to other recent British Standards for gem cutting tools.

Copies of the standard can be obtained from the British Standards Institution, 2 Park Street, London W1.

Making Air Fit to Breathe

Air pollution control provides clean air for operators inside a factory, and prevents the escape of pollutants to the outside. Some pollutants may be sold at a profit if recovered in a usable form.

In the 18 months since the Clean Air Act came wholly into force manufacturers of equipment to implement provisions of the Act have been busy, and a great variety of plant is now available. Much of it, of course, has been developed, tested in service and perfected over a long period, for the problem of atmospheric pollution is as old as industry itself. Progressive management had the problem well in hand long before there were any legal obligations to do so. Another factor, which is of increasing importance, is that changes in some industrial processes have involved the emission of large quantities of fumes within the works. Such fumes are objectionable under the Act and must be collected at source and prevented from escaping into the atmosphere. Steelmaking, for example is turning more and more to the use of oxygen in steel refining. The process gives a considerable increase in production, but evolves large quantities of oxide fumes which take the form of an intense orange smoke. It is in this connection that a further factor is developing, which can have far-reaching effects. If a gas has to be cleaned to remove its objectionable constituents, the dust, sludge, grit or other end product can either be disposed of by dumping—often a source of difficulty in itself—or it might be treated in such a way that it can be used in some part of the manufacturing process or as a saleable by-product. Effective means of using some of the end products of fume and gas cleaning have already been discovered and put to practical use.

COMBUSTION

Smoke from combustion of all kinds of fuel was recognised as a source of waste long before the Clean Air Act became law. Even in the eighteenth century the problem was appreciated and patents for smoke-consuming furnaces were taken out. Having had a long start, combustion engineering has developed into an exact science. Combustion, though there is a very wide range of equipment to deal with every kind of fuel, is affected by the slow but steady change in the quality of the two principal fuels, oil and coal. Crude petroleum has a rising sulphur content, and all over the world the best grades of coal are becoming exhausted. In the case of coal, the necessity for cost reduction by mechanisation has resulted in greater production of small sizes, which are only suitable for firing by mechanical means. This, however, is not the disadvantage it may seem, for mechanical firing is recognised as the only way to get the best out of the fuel and to burn it smokelessly. At the one time a skilled stoker using high-quality coal and a furnace in perfect condition, could achieve smokeless combustion for long periods. But neither the men nor the fuel are now available in the numbers and qualities needed, and the only answer is to mechanise.

The Coal Board have stepped up their efforts to develop new types of smokeless fuels and to increase production. In addition, both the coke oven and the gas industries can now supply coke in bulk. Automatic stokers exist to deal effectively with any kind of solid fuel, and fully automatic control of boilers and furnaces offers not only smokeless combustion but also appreciable operating economies. In the case of oil fuel, the same conditions apply; given properly designed equipment, maintained and used in the correct manner, smokeless combustion is certain. Equipment exists for the correct firing of any known fuel, solid or liquid, and it is not going too far to say that the smoke problem is capable of being overcome completely.

FUMES

Smokeless combustion is not the only requirement of the law. Some low-grade solid fuels are liable to produce fly-ash and certain products of combustion which must not be allowed to escape into the atmosphere. There are numerous methods of cleaning available, ranging from the simple cyclone—the oldest of all—to washing equipment and electrostatic precipitators. Sometimes more than one type of equipment will be combined in a complete plant. A cyclone, for example, will remove the heavier pieces of grit and dust from a gas, leaving more complicated equipment to deal with the lighter particles and objectionable gases.

Exactly what plant is used depends on so many factors that each problem has to be considered on its merits, and it is usual for a manufacturer's engineer to visit the prospective user and assess the problems in terms of the large range of equipment available. Electrostatic precipitators, such as the Holmes-Elex, made by W. C. Holmes and Company Limited, Huddersfield, or that made by the Sturtevant Engineering Company Limited, London, EC4, find extensive use in power stations, gasworks, metallurgical process works and many other industrial plants. Wet filtering is another well-tried method of dealing with dust. The Traughber filter (Joshua Bigwood and Son Limited, Wolverhampton) is an example of this type of dust removal equipment. There is a very wide choice of efficient filtering and dust removal plant on the market.

It is a legal requirement to protect operators by means of dust extraction equipment wherever harmful dust is produced. Foundry dressing shops are inevitably sources of dust; one of their functions is to remove the sand and dust adhering to the surfaces of castings. Cement works have a product which is itself of a dusty nature. Many chemical works, some pharmaceutical product factories, and countless others produce dust or grit or both, in varying quantities at some or many parts of the production line. A large range of plant is available and every case has to be considered separately.

Production dusts can be divided into two main categories; those which are normally of value and can be returned without treatment to the process line; and those which are normally of no value and must be disposed of outside the factory. Some pelletising and packaging processes provide an example of the first category. Here, given efficient plant for removing the dust from the point at which it arises, all that is necessary is a means of filtering and returning the dust to the process line. Dry filters, using a fabric bag or other cleanable filter medium may be the answer to this problem, coupled with dustproof collecting and transporting containers. Equipment of this type is included in the range made by Air Control Installations Limited, Ruislip. The dust or grit may have no normal use, in which case the wet filter collecting the dust as a sludge may be the solution.

BY-PRODUCTS

Some materials removed from process air, both gaseous and solid, have a potential use, though they are of no value in the form in which they are extracted. Two examples may be cited; iron oxide produced when oxygen is used in steelmaking, and sulphur from power stations. When oxygen is applied in the manufacture of steel—it can be used with all types of furnace—very large quantities of dark fumes are given off they consist largely of very finely-divided particles of iron oxide. This is a valuable source of metallic iron, but in fine dust form it is useless A method of recovering this oxide in usable form has been developed and applied successfully

on the Continent, and its application seems likely to spread. Oxide is washed from the fumes, the sludge is thickened until it has a moisture content of 25 to 30 per cent, and then mixed with lime. This dehydrates it, and a dry granular material results, which is suitable for charging to the blast furnace sinter plant. Here it is agglomerated with other oxide materials for use as part of the blast furnace charge. Lime is of value as a flux in the furnace, and the quantity in the charge can be reduced accordingly.

For recovery of sulphur from boiler flues a plant has been developed by the international Chemico organisation, represented in Great Britain by the Chemical Construction Company (G.B.) Limited, London, W1, who were also responsible for the filtering equipment used for iron oxide recovery. At present, large quantities of sulphur are discharged to the atmosphere. Control is now not only obligatory, it can be turned to financial advantage.

In the Chemico process ammonia gas is introduced into the flue gases between the economiser and the air heater. The ammonia reacts in the gaseous phase with the sulphur oxides produced by the combustion of the fuel, and the product consists of a fog of ammonium sulphur. The solid salts are removed as a powder from the gas stream in electrostatic precipitators.

From the precipitators a residue of ammonium sulphate salts and fly-ash is removed, and the fly-ash is separated, leaving the salts as a basis for the production of sulphate of ammonia. By this method a double advantage is obtained; the harmful sulphur products are prevented from entering the atmosphere, and a raw material for fertilizer manufacture is obtained. Sulphuric acid is, incidentally, one of the most expensive of the materials used to make sulphate of ammonia, and it is obtained here as a by-product.

It is in this direction, the recovery of economic by-products, coupled with the increased efficiency of correct combustion, that the application of the Clean Air Act may well have beneficial effects in addition to those for which it was primarily intended, the protection of people, buildings, and countryside from harmful effects.

Preserving Documents by Film Coatings

It may be necessary to preserve documents (which can be taken to include drawings and anything else written, drawn or printed on paper) for a variety of reasons. Archivists will be concerned with the preservation of documents for an indefinite period—" for all time "—as far as is humanly possible. This sort of operation is not likely to be of much interest to engineers, but documents are so important to engineering today that the question of treating them in some way to preserve them often arises. Various methods of preservation do exist, but there are no standards defining a suitable material. The National Bureau of Standards, United States Department of Commerce, has investigated the question and has published its findings in a brochure *Preservation of Documents by Lamination*.

It is not difficult to formulate a specification of requirements for a laminating material. Ideally, it should be very flexible, considerably stronger than the paper it protects, and have a considerable elongation beyond the yield point on a stress-strain curve. It should be resistant to abrasion and to degradation, that is, it should by its inherent stability resist any environmental conditions it might reasonably be expected to encounter. It should be possible to attach the film to the paper easily, without complicated equipment, and to remove it again without damage to the paper should this be necessary. Finally, the laminating film should be transparent to light throughout the visible spectrum and preferably into the infra-red and ultra-violet. At present there is no known film which meets all these requirements, but a properly formulated cellulose acetate is a good compromise. This material has, in fact, been used for document preservation for more than 20 years, though the information necessary to establish specifications for cellulose acetate film of commercially practicable quality was not so far generally available.

Tensile strength at break, kg per 15 mm width, min.	1·8
Tensile strength at yield point, kg per 15 mm width, min.	1·8
Elongation at break, min., per cent	15·0
Elongation at yield point, per cent	3·5±0·5
Folding endurance, MIT machine at 1 kg tension, double folds, min.	1,000
Thickness, mil	0·88± 10 per cent
Heat softening temperature:	
Moelter-Schweizer, °C	114·5±2·5
Copper block method, °C	123·5±2·5
Accelerated ageing for 40 days in moist oxygen at 124° C:	
Rate of change of intrinsic fluidity with time in days, max.	0·02
Time to reach an intrinsic fluidity of 1·0 in days, min.	40
Viscosity of cellulose acetate, centipoises, min.:	
Cast film	100
Extruded film	60

As a result of the NBS investigation, it is possible to list the basic requirements of a satisfactory cellulose acetate film for document lamination. The desirable physical properties are given in the table.

A suggested composition is: cellulose acetate, 73 per cent (by weight); plasticiser, 25 per cent; acid acceptor, 0·5 per cent; ultraviolet absorber, 1·0 per cent; antioxidant, 0·5 per cent (the last three quantities are desirable minima).

Alternatives to cellulose acetate have also been studied, but polyethylene and polyethylene terephthalate films are probably the only other films which are at present worth considering. Polyethylene appears promising, particularly the newer types of this material, and a chemically similar polymer, polypropylene. This group of polymers merits further study.

Bottled Gas for Industrial Power

Liquefied petroleum gas—LPG for short—is finding increasing use as a fuel for industrial internal combustion engines. It is not supplied for use on vehicles licensed to run on the public highway, but for all internal purposes it is freely available.

LPG is an ideal fuel for use in internal combustion engines, giving high efficiency, lively performance, and low running and maintenance costs. Because the fuel enters the cylinder as a dry gas, it mixes instantly and completely with the air, and there is complete combustion, resulting in virtually non-toxic exhaust and an absence of odour. This is of particular value when equipment is used in the food, drink and tobacco industries, and in many other factories where conventional exhaust gases are objectionable. In addition, with complete combustion, there is no wasted fuel to wash down the cylinder walls removing and diluting the lubricating oil, and there is very little carbon deposit. Consequently, plugs, oil and filters remain clean, and oil changes are much less frequent.

LPG is available from Shell-Mex and BP Gases Limited in two main grades, Bottogas (commercial butane) and Propagas (commercial propane). Bottogas is the fuel for larger engines, such as those in fork-lift trucks, and is generally supplied in 40 lb containers, which can be fitted to the vehicle. Propagas, supplied in 10 lb or 24 lb containers, is the fuel for smaller engines. For large users of LPG, storage installations are available, from which the vehicle containers can be refuelled by means of a hose.

Many manufacturers of fork-lift trucks, stackers, cranes, dumpers, tractors, sweepers and other equipment, include in their range models designed for running on LPG, but for engines not so designed, conversion kits are available. Obtainable from the Lipton LP Carburettor Company Limited, Wooburn Green, Buckinghamshire, the kits contain everything necessary for the conversion, down to the last nut and bolt, and can be fitted with standard tools. Fitting time varies according to the size and complexity of the installation, but is never more than a few hours. In a demonstration conversion of a small ITD fork-lift truck from petrol to LPG, a skilled fitter and two unskilled assistants completed the work and had the engine running again in less than 15 minutes.

There is no exhaust odour from LPG fuel. This can be important, as here, in a tobacco factory.

Fifty Years of Electricity Regulations

Just 50 years ago the Electricity Regulations were made, and it is a tribute to those who drafted them that with one slight exception they have remained unaltered ever since. The fact that such an important code should have proved adequate for half a century is due, says the report, *Electrical Accidents and Their Causes, 1958*, recently issued by HM Factory Inspectorate, to goodwill on both sides of industry, which has made it possible to interpret the *Regulations* in terms of the current state of electrical science and practice. Proof of the satisfactory nature of the *Regulations*, and their operation by the parties concerned, is contained in a comparison of accident figures. In 1907, the year immediately before the Regulations were drafted, there were 264 electrical accidents, eight being fatal. In 1958, in spite of the enormous increase in electricity supply and in industrial usage, the number of accidents had only risen to 714, including 38 fatalities.

A detailed analysis of reportable accidents (that is, those in which the person concerned " is disabled for more than three days from earning full wages at the work at which he was employed ") shows portable apparatus to remain a prominent offender, though the percentage of fatalities has decreased slightly. In this type of apparatus one-third of the accidents were due to the apparatus itself becoming faulty, and the remainder to cables, plugs, sockets and connections. The records show that even equipment which in itself is intrinsically safe can cause accidents if it is neglected, wrongly installed or damaged. This should be obvious, but accident statistics show that it is not always recognised.

A growing danger, which the *Report* illustrates, is that of contact with overhead power lines; accidents of this kind are frequently fatal, because of the nature of the voltages involved. In the past five years, 98 men have been killed by accidents of this type. Mobile cranes are particularly liable to accidental contact with power lines, and it is difficult to formulate rules for prevention, because circumstances are so different. "Goalpost" structures over approaches to a power line crossing are a useful safety measure. Cranes are not the only causes of such accidents. Hand tools, scaffolding, ladders, tipping lorries, are all recorded as having come into contact with power lines. The safest approach is to examine any outside job to see if power cables are even remotely in the area where work will be done, and then to arrange careful cooperation between all parties concerned before work starts.

Limit switches and safety interlocks are another frequent cause of trouble and danger when, as so often happens, they fail because of dirt, neglect or damage. Similarly, apparently small things such as a fence which did not reach to the ground and permitted unauthorised persons to enter a substation, or even the use of 12V inspection lamps in the vicinity of petrol, all caused accidents which ought never to have happened.

Heavy Electrical Plant

The heavy electrical machinery industry has recently had to adjust itself to changing conditions. Over the last year or so the industry has had to take into account the modification in the nuclear power programme, the slowing down in the rate of expansion of the capacity of the electricity supply industry between 1961 and 1963, and the effects of the Restrictive Trades Practices Act on tendering and pricing policy. There is some prospect that for the year ahead the outlook is rather more stable than was the case in 1959. This is partly because the industry has made its adjustments so far as the home market is concerned and partly because abroad, with the gathering momentum of the United States recovery and the ability of the primary producing areas to spend more on heavy capital equipment, exports should be comparatively buoyant although competition is likely to be keen.

In the home market the main determinant of prospects for the heavy electrical equipment industry is, as always, the electricity supply industry. This applied not only to transformers and generators but also to heavy cables and the whole range of ancillary electrical equipment. In 1959 the approved plant programme for the Central Electricity Generating Board was 1,647 MW. In the current year it is 1,898 MW building up in 1961 to 2,404 MW. Thereafter there will be a gradual decline until 1964 when the figure is expected to be 1,727 MW. It is expected that by the end of 1964 some 90 per cent of the Board's total electricity output will be from conventional generating plant, mostly coal fired and about 10 per cent from nuclear plant.

The broad picture is therefore one of gradual expansion of the electricity supply industry's investment programme until 1961 followed by three years when the programme will be reduced to be succeeded by several years of an enlarged programme. The industry is thus already engaged in delivering equipment for the initial period of expansion and has already absorbed into its plans the consequences of the slower rate of expansion between 1962 and 1964. At the planning stage therefore it is about to face a period of expansion for the years 1965 and 1966. Over the years 1959 to 1964 new generating plant with an output capacity exceeding 12,300 MW will have been installed in 25 new power stations, eight new stations partially in operation early in 1959 and five new sections of stations.

The deceleration in the nuclear power programme has been accompanied by a slowing down in the rate of changeover in conventional power stations from coal to oil. Two power stations due to be changed from coal-firing to oil-burning have had the changeover postponed for 12 months and the conversion of certain additional boilers at one other power station has also been deferred. Certain boilers due for conversion to oil at another power station will not be converted at all.

Continuing expansion of the Board's generating capacity over the next few years is to be accompanied by a further increase in the mileage of the Super Grid. This 275,000 volt system is to have a further 1,000 miles added to it by 1963. By that time there should be more than 1,900 miles, nearly all of it double-circuit, of Super Grid. This should help to ensure a steady demand for heavy cable.

A good deal was heard in 1959 about the effect on amenities of power station sites and power cables. Sir Christopher Hinton, chairman of the Central Electricity Generating Board, and Sir William Holford, professor of Town Planning, University College, London, and a part-time member of the board, gave papers before the Royal Society of Arts towards the end of November on "Power Production and Transmission in the Countryside: Preserving Amenities." Sir Christopher was much concerned with the cost of preserving amenities when the siting of a power station or running of an overhead cable gave very large cost advantages over an alternative site or underground cable. Sir William Holford spoke of the work which has been done on design of power stations to give an alternative amenity.

Meanwhile the decision has gone against the preservation of existing amenities (and in favour of low costs) in the controversial issue about the route of the Kent power line. The 275 kW overhead transmission line, by a decision of the Ministry of Power, is to go from Northfleet to Canterbury south of the Medway towns instead of to the north.

The electrical machinery makers have since the war enjoyed the advantages at second hand of a national policy of expanding the supply of electric power as quickly as possible. Whatever industries went without capital, they included the railways and roads, the electric power industry was not one of them. Although there is not going to be a cut-back in that industry's capital expansion programme the priority of other industries has moved up.

It was not surprising that top priority for power led in the end to over-optimism. The electrical machinery industry, along with coal, has shared the consequences.

The second factor was the economic recession of 1957 and 1958. Electricity, along with other public utilities, was called upon in the later months of 1957 to spread its capital investment programme more thinly over the next few years. This has led to a faltering in the rate of expansion between 1961 and 1963 and a slowing down in the rate of development of nuclear power.

The third factor is growing competition in export markets both where there is a large domestic industry already established (as in the US) and in markets in the as yet non-industrialised parts of the world.

Exports

In the export field, heavy electrical equipment in 1959 followed on the whole the trend of electrical machinery in general. In the first ten months of 1959 exports of electrical machinery were 11 per cent lower than in the same period of 1958. 1958 had been a better year than either 1957 or 1956. Deliveries for export of steam-turbo alternators of 10,000 kW capacity and over were slightly better than in the first seven months of 1959 and in the same period of 1958 and the same is true of the heavier type of rotating electrical machines. 1959 opened with the set-back in the United States market when the English Electric bid for the turbines at Greer's Ferry was turned down on grounds of "national security." The outlook in the United States market is still highly problematical for as the year has gone on the Administration has become more rather than less tariff and quota minded.

Over the next decade the prospects for heavy electrical machinery manufacturers are at first sight not dissimilar from those during the 1950's. Throughout the world there is a clear tendency for plant programmes in the electricity supply industry to be concentrated in larger units. Increasingly, therefore, it will become a matter of winner take all. Competition is likely to become more intense with a larger proportion of the world's new installations being financed by the World Bank or other international organisations.

So far as generating sets, generators and the electric motors were concerned, the pattern of the overall total was reproduced. The big markets were the Dominions and United States. In converting machinery, transformers and switchgear the main markets were South Africa, India, Australia, Rhodesia and Venezuela. It is significant that a high proportion of export business in electrical machinery is with Africa, an area which is likely to have its economic problems in the next year or two.

Manpower

The heavy electrical industry enters 1960 with a number of significant changes in organisation. Whatever these may do to labour at shop floor level, there are certain important implications for management. In 1959 price restriction agreements within the industry affecting both electricity generating equipment and cables have had to be dismantled. This process has played an important part in the reorganisation of both Associated Electrical Industries Limited and the General Electrical Company Limited. With competition taking the place of organised and orderly bidding, a certain amount of steamlining of subsidiary companies in these groups has become desirable. In the AEI group such well known names as Metropolitan-Vickers and British Thomson-Houston disappear.

A process of rationalisation has also been taking place in the cable industry. Even the larger companies have had to concentrate production on their most efficient plant and this has involved the closing down of certain factories. A price war developed in the middle of 1959 which has since petered out and the industry enters 1960 with a smaller and more concentrated capacity than it had a year before. The fact has to be faced by the industry, however, that the old pattern of a competitive export market (in which business had been increasingly difficult to obtain over a number of years) with a protected home market on which the industry mainly relies for its profit has given place to a state of competition in both the home and export market.

Over the first nine months of 1959 there was a modest increase in employment both in electrical machinery and in electrical wires and cables. Numbers employed in electrical machinery went up from 211,000 in December, 1958, to 212,000 in September, 1959, while over the same period numbers employed in electrical wires and cables increased from just over 59,000 to just under 60,000.

Plant and Product

The size and steam conditions of power station plant continues to increase. The size of installed capacity is also becoming rather more varied. Power plant programmes put together at the beginning of 1958 contain sets ranging up to 200,000, 275,000 and 550,000 kW. In the programme arranged for the period ending 1964 the size of sets ranges from 120,000 kW to 550,000 kW. Sets within the range of 300,000 and 375,000 kW are being ordered for the first time.

Over the last ten years the number of steam power stations has increased from 198 to 207 while electricity generated has increased from 42,603 million units to 91,565 million units. Over the same period total works cost per unit of electricity sent out from power stations had increased from 0·4975 to 0·6445. Also over the ten year period the number of employees (including technical and supervisory staff) per megawatt of output capacity fell from 2·81 to 1·63. Thus, although there has been a significant increase in cost per unit of electricity amounting to 30 per cent, there has been a significant improvement in productivity. Over the same 10 year period there has been a useful reduction in the average time of withdrawing generating capacity due to overhauls, breakdowns and other causes. Reductions due to overhaul fell from 4·1 per cent in 1948/49 to 0·4 per cent in 1958/59. The corresponding figures for breakdowns were 6·4 and 6·1 per cent.

At the turn of the year, work began on the largest single-furnace boiler in the world. It is being supplied by Babcock and Wilcox Limited for the Thorpe House power station near Doncaster. Its steam will drive one of the new

550 MW generators, burning about 200 tons of coal an hour to produce 1,675 tons of steam an hour.

Materials

The interesting feature on raw materials for the electricity machinery industry at the beginning of 1960 is the future of the price of copper. Over the closing months of 1959, the metal remained comparatively stable at just over £250 a ton. Yet this stability was the outcome of a number of major unstabilising factors pulling against each other. Since the financial crisis of 1957 and the world economic recession, copper prices have moved upwards from about £160 a ton, having plummeted from over £400 a ton in the previous year.

Had the world copper mining industry been free from strikes recovery would have been a good deal slower than happened in the event. A fairly sharp recovery to about £210 a ton brought a good deal of marginal capacity back into production and the voluntary cut of 10 per cent by the Rhodesian Selection Trust Group had little effect as an example to other big producers.

What of the future? It seems likely that a big expansion in industrial activity, led by the United States now that the steel strike is over, could move prices up but nowhere near the heights reached in 1956. In January there is a backwardation of £10 a ton which indicates the pressure on the market for immediate cash copper compared with the three months delivery price. World stocks are still low and the price of copper may not falter as American capacity comes back into production. It does not look, however, as though the price this year will get over £300 a ton. At around £250-£260 a ton the point is being reached when aluminium (with its record of exceedingly stable price compared with copper) becomes increasingly attractive as a substitute.

The high level of copper prices a few years ago stimulated the search for substitutes and more economical designs in the use of copper. Once work on these lines is started it is not given up when copper stays at bargain levels (as it did early in 1958) for a few months. Users have become exceedingly sensitive to the wide fluctuations of copper prices and two conferences were held in the second half of last year in Paris to achieve more stable prices—without success.

Meanwhile it is not without significance that the announcement by AEI of the availability of the first water-cooled power cable in the world claims as one of its advantages a reduction in the use of copper.

Research

As yet, no other heavy power generating technique has reached the stage where it could replace the steam turbine for the economical generation of large scale power. For this reason, two approaches to improvements for the future are being made in parallel: developments to existing techniques, and research for radically new ones. Developments in existing techniques have been advancing steadily on a broad front for some time and considerable progress has been made, but, in the long run, radical changes will undoubtedly be needed if progress is to continue in the more distant future.

In assessing radical developments and likely avenues of approach for new forms of energy, it seems logical to take into account the enormous quantities of radiated energy that reach us from the sun. Attempts to harness this energy have been going on for generations, but if ever it is to be of any practical use then a number of radical engineering developments are going to be needed. The most vital of these would be either a practical means of storing electrical energy or a much improved technique for converting the radiated engery directly into electricity.

Storing electrical energy in a practical manner has been the dream of engineers and scientists for many years and, although research still continues, it does not seem to be a very likely avenue for future progress. However, improved techniques for converting heat directly to electricity are becoming increasingly promising as a means of improving the present state of power production. The two most likely techniques, which have made rapid strides during the past year, are thermoelectric generation and thermionic conversion. Together with nuclear fission, they may well become the mainstay of bulk power production at some time in the future.

As a result of intensive research in solid state physics over the past decade, semiconducting materials have been developed with which it has been found possible to construct very much improved thermopiles, using the Seebeck effect. In both America and the USSR practical use, on a small scale, has been made of these devices and research is now going ahead in leaps and bounds. Just a year ago an announcement was made in Washington that a thermoelectric generator, using fission product heating, had achieved an efficiency of 6 per cent.

Several decades ago O. R. Richardson discovered interesting effects arising from thermionic emission by means of which small voltages and current could be produced. At the time, the likelihood of obtaining power from such a technique seemed very remote indeed, however, recent investigations have shown that it is certainly feasible. The technique has now been used to construct a number of devices for converting heat directly into electricity at high temperatures. Experiments carried out in the USA have achieved efficiencies of the order of 10 per cent.

Although neither the thermoelectric nor the thermionic technique is yet anywhere near being a practical source of bulk power, research in both fields is progressing so rapidly that high hopes are held for the future. It is visualised that the two techniques could be combined and that they might together achieve efficiencies of the order of 30 to 40 per cent, or more, in the not so far distant future. Each of these two techniques gives a unidirectional current output; neither would be capable of producing alternating current without additional machinery.

Yet another possibility for future power production is the fuel cell. Having a comparatively high efficiency in its present state of development, the main barrier to its practical use is one of cost.

Although great strides have been made in basic research into new techniques, it is quite on the cards that the old established methods will have to be relied on for some time yet. Therefore our practical progress will be limited by the developments that have a direct bearing on power generated in the conventional way. Thus, new knowledge in the fields of magnetism, physics, and chemistry (including such matters as lubrication, insulation, corrosion, combustion, etc.) will be required to continue to improve the efficiency of performance of the existing forms of electrical machinery.

Design

It is not so very long ago that electrical generating plant was made up of 30 megawatt sets. Now, a unit of 200 MW is already operating in the East Midlands at High Marnham power station, where by 1962 there will be five such units, giving an output of 1,000 MW all told. At West Thurrock, in the eastern division of the Central Electricity Generating Board (CEGB), the power station will by 1964 have two 200 MW units and two 300 MW units, while at Thorpe Marsh in Yorkshire, there will be two 550 MW generating sets, the largest in the world, by 1963.

This policy of installing large generating sets keeps down the capital outlay on conventional power stations—they cost no more per kilowatt—and also the cost of electricity.

Probably the most significant event for CEGB in 1959 was the installation of the first 200 MW, 3,000 r.p.m. reheat system turbine at High Marnham power station, situated on the west bank of the River Trent. When completed in 1962, with its five 200 MW sets, the station will be the largest in Britain and, in fact, Europe. Designed by the English Electric Company Limited, the alternator is hydrogen cooled. It employs direct cooling of the stator and rotor conductors at a rated gas pressure of 30 lb per sq. in. The hydrogen coolers are arranged longitudinally in the upper part of the stator frame, the hydrogen being circulated through the coolers by an axial fan blower. Not only is this the first 200 MW reheat steam generator to be commissioned but it is the first boiler unit embodying the principles of controlled and assisted circulation designed by International Combustion Limited.

At West Thurrock power station, now under construction in the eastern division of CEGB, it is planned by 1961 to have two 200 MW turbo-generators designed by Associated Electrical Industries Limited (turbine-generator division) and two 300 MW C. A. Parsons and Company Limited turbo-generators by 1964, the completion date. The planned capacity of the station is thus 1,000 MW. Each unit will have the greatest single line output in the world. The stator windings will be direct water cooled and the rotor windings direct cooled by hydrogen at a gas pressure of 30 lb per sq. in.

Two 350 MW single-shaft generating units are to be supplied by English Electric for the Drakelow C power station near Burton-on-Trent. Located on the fringe of the East Midlands coalfield, a major source for the low grade coal used in electricity production, the station will be close to the areas of heavy demand in the central Midlands and will thus be in a good position to supply them with electricity economically. Since the site of the station is also a focal point in the 275,000 volt Supergrid transmission system, no further transmission lines will be needed.

The associated boilers, to be manufactured by John Thompson Water Tube Boilers Limited, will be of the reheat type producing 2·45 million lb of steam an hour at a pressure of 2,400 lb per sq. in with primary and reheat temperatures of 1,055° F. Drakelow C will have four 350 MW units by 1964.

Plans are going ahead for the extension of Blyth power station, Northumberland, by the addition of a new section to be known as Blyth B. Orders for the first set of two 275 MW generators, to be ready by 1962, have been placed with English Electric and with Yarrow and Company Limited for the boilers. The turbines will be of the single line (tandem compound) type, running at 3,000 r.p.m. Each will drive a generator, the stator and rotor windings of which will be cooled by hydrogen at a pressure of 45 lb per sq. in, circulated inside the coils by a high speed blower. The boiler will have an evaporative capacity of 1·9 million lb of steam an hour at a pressure of 2,400 lb per sq. in and a final steam temperature of 1,055° F. Later, when the power station is completed in 1963, there will be an additional two sets of 300 MW, to give an output of 1,150 MW.

Of the two 550 MW turbo-generators for Thorpe Marsh power station now under construction near Doncaster in Yorkshire, and due for completion in 1963, the first will be supplied by C. A. Parsons and Company Limited and the second by Associated Electrical Industries Limited. These sets will be the largest two-speed conventional cross-compound machines in the world generating at 50 c/s. They are expected to operate with an overall station efficiency that is 7 per cent better than the previous best, Castle Donington. Each turbine generator will consist of a multi-cylinder steam turbine, divided into two sections on two separate lines, each driving a 275 MW a.c. generator. These two generators, although of equal output, will differ in size, because one will run at 3,000 r.p.m. and the other at 1,500 r.p.m., but both will have water-cooled stator windings. The cooling water circulates through the live conductors, which are made from copper in the form of thick-walled tubes of rectangular section.

Domestic Appliances

Manufacturers of domestic appliances except their performance this year to be even better than in 1959 although they do not anticipate such a marked increase in the rate of sales. Competition is likely to become more intense as the upward growth in demand flattens out and importers are unlikely to concede their recently gained strong position without a fight. In addition, further price cuts are likely following the trend shown over the last few years. Pressure on price is likely to be touched off by further imports of competitive domestic appliances, particularly from Germany where manufacturers of refrigerators have had less favourable conditions in their home market than United Kingdom producers in theirs.

Last year was a boom year for manufacturers of domestic appliances. Under the influence of relaxed hire purchase arrangements conceded in December, 1958, and the reductions in purchase tax on several items of domestic equipment contained in the 1959 Budget, conditions were extremely favourable for a large advance in production and sales. Delivery of home-produced domestic appliances expanded by nearly 70 per cent last year and there was also a very large increase in sales of imported refrigerators and washing machines.

The increase of imports of continental appliances also gives rise to thought about the possible future effects of the European Common Market on producers in this country. If foreign appliances can be sold successfully over the trading barrier here, they must be sold at even more competitive rates in the countries of the Six. This seems to imply that British sales of domestic appliances in these countries are likely to become still less competitive in the future, and a further drop in exports to Europe is to be expected. Looking even further ahead, should the time come when Intra-European trade barriers are swept away as a result (admittedly improbable for some time) of a bridge between the Six and Seven, it may well be that UK sales of domestic appliances could also suffer. It is known that activity in domestic appliances is increasing rapidly on the Continent. Although the French manufacturer Cemam Concord reported difficulties as a result of credit restrictions and falling demand, they last year designed and successfully tested two new types of washing machines, and set up a sales subsidiary in Germany. This reflects considerable optimism in the future as a result of the European Common Market. Meanwhile, from Italy came reports that Compagnia Generale di Elettricita, Milan, have been selling increasing quantities of consumer goods, not only in European but in Commonwealth markets. Among other factors which may make European trading, even in the Outer Seven, more difficult, are the plans of the Portuguese subsidiary of the American General Electric Corporation to make a wide range of domestic electrical equipment in Portugal.

Exports

The export position for UK domestic appliances is indeed far from favourable. In 1959, exports of many types of appliances showed a marked drop and overall exports were down by about 20 per cent. There was a particularly large fall in exports of domestic refrigerators, from £6·4 million in the first nine months of 1958 to £4·9 million in the same period of 1959. Meanwhile, exports of dry shavers fell from £864,000 to around £380,000 in the same period and exports of electric blankets and pads dropped from £48,000 to about £5,000. When a large increase in home demand needs to be met, it is natural for exports to suffer and this was particularly the case last year when UK domestic appliance manufacturers were strained to the limit to meet the demands placed on them by distributors in the home market. Competition from continental manufacturers, particularly in Germany and Italy, also increased and no doubt had its effect on UK exports of domestic equipment.

While in 1959 there was little obvious cause for concern over the low export figures, seen in the context of the large overall increase in sales, there are certain dangers in too much dpendence on the strength of the home market. In 1959, distributors were consistently ordering stocks well in excess of their immediate needs in anticipation of an increasingly high level of demand. There is a very real danger that manufacturers may be persuaded to gear their rates of production to distributors' stock demands and not to the requirements of the ultimate consumer. Little is known about the statistical level of distributors' stocks of appliances but a very rough indication is made possible by examining the changes in retailers' sales of " radio and electrical goods " and comparing them with published figures of deliveries of appliances. In the period January to September, 1959, for example, sales of these goods by department stores were up by 28 per cent and by independent retailers by 14 per cent compared with the same period of 1958. By contrast, home deliveries to the trade of domestic refrigerators rose by over 80 per cent, electric blankets and pads by nearly 40 per cent, vacuum cleaners by over 50 per cent and washing machines by 95 per cent. This strongly suggests that distributors have been over-stocking in 1959 and 1960 may see a very much slacker demand for appliances while stocks are being run down. While on the face of it there is unlikely to be any tightening of credit facilities in the 1960 Budget, there is bound to be some slackening of demand in the early months of 1960, as distributors await its outcome. Meanwhile, a harsh Budget could be disastrous for domestic appliance manufacturers.

Between January and September, 1959, imports of washing machines into the UK totalled 970,200, compared with 32,800 for the whole of 1958. Domestic refrigerator import figures are even more startling. In 1958, domestic refrigerator imports totalled 2,300 units. By September, 1959, this country had imported 137,200 machines. To some extent this was no doubt due to the strong pressure on UK manufacturers for supplies. It is also, important to remember however, that most refrigerator manufacturers distribute direct to retailers while wholesalers need to rely largely on imports for their supplies. In addition, continental refrigerator manufacturers have not been experiencing such favourable conditions and in the circumstances have been ready to dispose of some of their output in the UK at competitive rates.

Competition is also likely to increase from new sources of supply at home. Several manufacturers hitherto outside the domestic appliance field have announced their intention of entering the market, and some examples are referred to in a later section of this article. An additional source of competition of growing importance in some items of domestic equipment is the second-hand market. This is said to be particularly strong in washing machines and vacuum cleaners, although no precise figures are available. Nevertheless, demand for reconditioned machines is growing and is likely to develop still further in 1960. To some extent this is no doubt due to the seemingly high cost of repairs which in its turn may be caused by the system of distribution whereby in a large number of cases machines have to be returned to the factory for repair work. Housewives often find that they can obtain a reconditioned vacuum cleaner for little more than the cost of extensive repairs to a worn one. This in its turn may well effect the replacement market and with such a large proportion of households now owning such appliances as vacuum cleaners, the replacement demand is assuming increasingly important proportions. In the long run, however, the growth of a strong second-hand market may be as beneficial to domestic appliance manufacturers as it has been to the motor vehicle industry.

Another factor causing concern last year and dealt with later in this article was the growing pressure on raw materials as production rose.

Manpower

Manufacturers of domestic appliances were fortunately free of major labour disputes in 1959. Indeed, labour appears to have responded well and overtime was widely worked through much of 1959, but this may mean demands for higher wages in 1960. The unions are sensitive as regards taking up a bargaining position to the trend of overtime earnings. Obviously, this had little effect on prices for in fact many producers were able to make price reductions due to other economies, principally owing to their scale of production.

Employment figures for domestic appliance manufacture are not available in detail but a useful indication can be obtained by studying the published figures for employment in " electrical goods not elsewhere specified." Numbers employed under this heading stood at 200,700 in October, 1959, compared with 181,900 in October, 1958, an increase of over 10 per cent. Meanwhile, unemployment in this category fell from 2,399 in November, 1958, to 1,142 in November, 1959, making the unemployment ratio in the latter month less than 0·6 per cent. To some extent, this is explained by the bringing into production of new capacity by several large domestic appliances manufacturers. Hoover alone has recently claimed to have increased employment in Scotland and South Wales by well over 1,000 and to have provided 500 additional jobs in their factories at Perivale and High Wycombe. Further expansion plans for this company and other large manufacturers should ensure a healthy employment situation in 1960.

Plant and Power

The expansions of capacity briefly mentioned in the preceding section should, besides providing employment to many people in some less developed regions of the country, help to ensure that any future increases in demand will be adequately met without unduly straining plant. Among plans to expand plant announced last year, Hoover are carrying out a 100,000 ft extension at Merthyr Tydfil and have also acquired the lease of a 68,000 ft factory in that area, besides extending their plant at Cambuslang, Lanarkshire, by 88,000 ft; AEI-Hotpoint Limited are extending space at Peterborough and Llandudno Junction while Pressed Steel are building a major new factory at a total cost of £5 million, in the depressed Swansea area. While this will not be in production this year it should provide employment for about 4,000 in 1961 when it is planned to be in full operation for the manufacture of 8,000 to 10,000 refrigerators per week. Tricity Cookers Limited, a Thorn Electrical subsidiary, who last year introduced a " built-in " electric cooker, are adding 40,000 sq. ft of space to their Spennymorr factory.

Other companies plan to expand their range of products. Thus Kenwood, manufacturers of kitchen appliances (notably the Kenwood range of mixing machines), plan to make washing machines and refrigerators in 1960 under licence from the Norge Division of Borg-Warner (USA). Ronson have now launched their " Hood'n Comb " hair dryer manufactured by the Ronson Corporation of America. Birmingham Sound Reproducers, whose success in the tape recorder field has been a feature of recent years and in whom interest has been shown by United States investors, plan to enter the refrigerator field this year. Aerialite, cable manufacturers, plan to produce hair dryers and spin rinsers this year.

The most likely future advances in domestic

appliances are likely to be in the field of washing machines and refrigerators. While 83 per cent of British households now have electric irons and 65 per cent have vacuum cleaners, only 30 per cent have washing machines and 10 per cent refrigerators. It is interesting to note that on average 20 per cent of West European households own refrigerators and in Sweden, where climatic conditions are more severe than in this country, 60 per cent own refrigerators. This suggests that there is still a considerable potential to be tapped in this country. Furthermore, unlike some manufacturers of domestic appliances, refrigerator manufacturers are not materially affected in the short run by the presence of a large market for second-hand appliances.

Refrigerator manufacturers were undoubtedly helped in 1959 by the unusually fine summer. Between May and August last year, for example, deliveries of refrigerators to UK distributors by British manufacturers amounted to 389,200 units as against 225,400 machines for the same period of 1958. There have been suggestions that this country is to experience about 20 years of fine summers, and while long-term weather forecasts have recently been shown to be suspect, refrigerator manufacturers are still said to be optimistic about British weather.

A feature of the last few years has been the steady fall in prices of durable household goods. In October, 1959, the retail price index for "radio, television and other household appliances" stood at 89, the base being taken as January, 1956. Price reductions announced in 1959 undoubtedly contributed to this fall. In October, Hoover announced price reductions on some of their washing machines and cleaners while GEC cut the price of their basic range of immersion heaters by 10 per cent and that of two models of refrigerators by 4 per cent. Both companies said that these reductions were made possible by increased output and improved production methods. It is to be hoped that 1960 will see further price reductions.

Hire purchase expenditure on domestic appliances continues to expand rapidly and hire purchase debt on such items as washing machines and refrigerators more than doubled in 1959. A feature of last year was the growing interest shown in hire purchase by manufacturers of domestic appliances. One example was the formation in September of United Electrical Finance by AEI. This has an authorised capital of £500,000 and was set up with the objects of financing the hiring or hire purchasing of goods produced by the AEI Group and goods for which the Group provides components.

While in the immediate future there may be some slackening in the demand for domestic appliances, the long-term demand is likely to mount steadily. Since 1949, real expenditure on domestic appliances (allowing for price changes) has risen by nearly three times, compared with an increase in total real expenditure of about one quarter. While the new market for such items as vacuum cleaners and electric irons has probably reached saturation point, the potential for relatively new appliances such as electric polishers is great. Housewives' interest will continue to be centred more and more on labour saving "integrated" kitchens, which modern builders often make the focal point of new houses. This is likely to lead to an even greater future demand for such products as built-in cookers, both gas and electric, while fitted refrigerators may become standard in new houses costing more than about £3,000 within the next few years. Given the necessary incentive of a bright and modern-looking kitchen, the housewife is now more likely to invest in such items as washing and washing-up machines, spin-dryers and the like. The demand for electric food mixers is also likely to expand.

Raw Material

The price of raw materials used by the domestic appliances industry was steady in 1959 and in some cases fell. Thus, the wholesale price index (1954 = 100) of steel sheets declined from 127·5 to 125·9 between September, 1958, and September, 1959, while the price index of iron castings fell from 131·0 to 130·6 in the same period. The rolled aluminium price index rose slightly, from 122·8 to 124·7 but this should not have a significant effect on prices of finished domestic appliances.

While the price of raw materials caused no great concern in 1959, the supply position, particularly of finished steel sheets, was problematical. By September, 1959, total deliveries of finished steel sheets to all industries was only 7 per cent up on September, 1958, and manufacturers of domestic appliances had to compete with other industries (notably the booming motor car industry) for their supplies. Shortages of sheet steel have caused particular concern to manufacturers in the Midlands.

Research

Certain developments that have occurred in industrial techniques in recent years could well be adapted for use in the home but, strangely, there seems to have been no great move to exploit this. Techniques such as microwave heating, ultrasonic cleaning, electroluminescent lighting and thermo-electric refrigeration could, with sufficient development, become a boon to householders by more than halving the time and labour involved in domestic chores.

So far the Americans are leading the field in the development and adaption of industrial techniques for domestic use. One company has already developed a prototype, two-section oven, in which one section is operated by a magetron oscillator whilst the other is a standard electric oven. The magetron oven, which works at ultra high frequency, is intended mostly for baking where it can save hours of time with its penetrating dielectric heating; small cakes, for instance, can be baked in about three minutes.

Used for baking, the dielectric oven can be made much safer than the eddy current heater which was once proposed as a surface cooker, where its action was to heat metallic containers by induction. This technique was much too dangerous for ordinary housewives to use. For instance, if a hand came within range of the output coil (as might well happen when stirring over a saucepan) any metal object in the hand, such as a ring on a finger, may well become suddenly very hot. Even in industry, where skilled men are employed, accidents occasionally occur with this type of heating.

Perhaps the biggest boon that any housewife could wish for is a simple, effective washing-up machine. Here again, American developments, by the Westinghouse Electric Corporation, seem to be leading the field. By re-employing industrial cleaning techniques that have become widespread throughout industry in recent years, Westinghouse have been able to produce what appears to be an effective, prototype dishwashing machine.

Working from ordinary mains, the dishwasher generates oscillations at about 20 kc/s which, through a transducer, impart ultrasonic vibrations to the dishwater. These vibrations are said to act quickly and effectively on the dishes in the water, cleaning them thoroughly in a few moments. The cleaning is undoubtedly more thorough than is normally achieved in routine washing-up operations. Since 20 kc/s is outside the hearing range of most people, the process is not accompanied by an uncomfortable piercing noise, as many industrial ultrasonic processes are. In addition to their speed and efficacy, ultrasonic dishwashers have no abrasive action, so there would be no wear on utensils washed in this manner and they could be kept looking new almost indefinitely.

The television receiver is the best engineered and most scientifically advanced piece of equipment to be found in any ordinary home; but still research and development continue in an effort to effect further improvements. Last year the outstanding improvement was probably the new "slim look," which at the same time improved the appearance of the cabinet and the definition of the picture.

This improvement was made possible by developments in the technique of scanning cathode ray tubes, improvements to output valve characteristics and better glass forming techniques. Together, these have resulted in an increase of the scanning angle from 90° to 110°. This has made a significant difference to the overall depth of cathode ray tubes and consequently reduced the depth of cabinets to very much more reasonable proportions.

Design

Some of the more up-to-date domestic appliances have been slow to catch on in this country, mainly because of the resistance of the housewife to new-fangled gadgets, as she calls them. American influence has, however, broken down the resistance to certain items like washing machines, refrigerators and drying machines, but the acceptance of dishwashers, ironers, and so on, is slower, probably because of their cost.

As far as cookers are concerned, there is a tendency towards modular kitchen units, consisting of a separate cooker, fairly high up, and a hot plate unit at waist height a few feet away. Both gas and electric cookers now have timing controls so that the cooking does itself while you are out and the meal is ready when you return. There are also infrared cookers that enable a roast to be prepared in a matter of minutes. Some gas cookers have an electrically operated rotating spit (barbecue grill) at eye level; others have thermostatic controls so that milk (the worst offender) will not be allowed to boil over.

One British electric cooker, not yet on the market, will be fitted with a timer and a very high speed hot plate. The hob is to be 33½ in from the ground (tests have shown this to be a desirable height) and the hob will be dished, so that spilled material cannot get down below the plates.

Another cooker recently introduced features for the first time a combined drop-down counterbalanced door with a separately counterbalanced full-view inner glass door; yet another has three fast-boiling hot plates sealed to the hob, to prevent spillage penetrating below them, and an oven with a large grill fitted with an anti-splash grid. An Italian cooker follows the Continental trend of grouping the appliances together, by having the high oven and cooking top, complete with condensation hood, all grouped with the storage cupboards. There is also the microwave cooker developed in the United States.

One recently introduced dishwasher is small and portable. It does not have to be fixed permanently in one place, since the water connections consist merely of two lengths of hose, one for supply and the other for draining. It fits snugly into a cabinet or can be stood on the draining board. Another type, developed in the USA, is ultrasonic and operates at 20 kc/s, a frequency which is above the range of the normal ear, and so the machine is silent in operation.

Last year also saw the introduction to refrigerators of aluminium evaporators made by the roll-bonding process. Another development was the introduction of a sliding hinge to enable a refrigerator door to be opened in a width no greater than that taken up by the refrigerator itself.

One new vacuum cleaner is designed so that the housewife can do all her cleaning with just two tools. With one, she cleans the floors, carpets and hard floors; with the other she does all the dusting, soft furnishings and stairs. One special feature of this machine is that it has throw-away bags for easy disposal of household refuse.

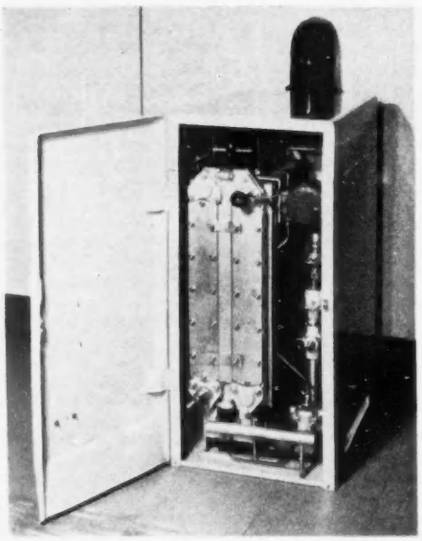
A water heater was introduced for use in the kitchen that will heat any quantity of water up to 1 gallon to boiling point, or to a lower temperature by thermostatic control. The heater is filled by a flexible hose from the water tap and so no plumbing is required.

House Heating by Gas

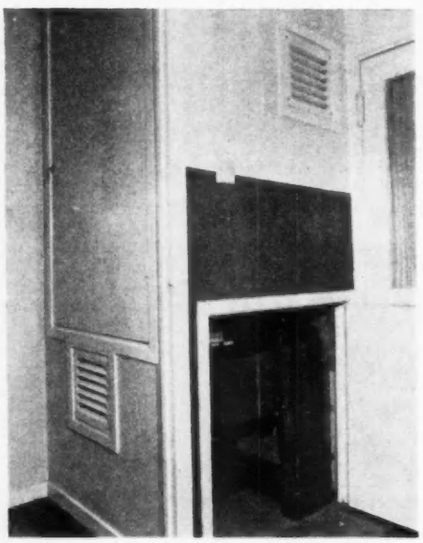
For many years, America has been looked upon as the land of central heating. Today, in offices, factories, shops and homes throughout Britain, this form of heating is making great headway. In this field, gas is becoming popular as a fuel because a gas-fired central heating or warmed-air unit requires little maintenance—and valuable space does not have to be sacrificed for fuel storage.

There are two basic forms of gas centralised heating—the circulation of hot water through pipes and radiators, and the warmed-air method by which air is heated in a central unit and is then passed through ducts to outlet registers in the rooms.

The growth of domestic central and warmed-air heating during the past year or two has been quite remarkable. A number of builders now install it as a standard fitting in some of their new properties. Many local authorities, too, have become very interested in the possibilities of centralised heating in new houses they are



The Diplomat gas fired boiler is a compact unit for central heating systems.



For hot-air circulation, the Halcyon can be fitted between the kitchen and the lounge.

building—at Aylesbury, for example, the local authority found they could install a warmed-air system in a three bedroom house costing £1,350. An estimate of the running cost of the gas heating unit in this case was 12*s* 6*d* a week during the "heating period" of the year, making an average cost over the whole 12 months of only 8*s* 6*d* a week. At Harlow New Town, also, the development corporation have installed gas-fired warmed-air heating units in a wide range of flats, as well as old people's bungalows.

Where central or warmed air heating is included in a house under construction, and where it is not intended to have any open fireplaces, a considerable part of the cost of the central heating equipment—including the time-clock and thermostat—and installation expenses is balanced by the saving on expensive brick flues.

Warmed-air systems are made in two forms. In one, air is drawn into a direct heat exchanger, which is heated by gas, and then passed through ducts to outlet points in various rooms. In the other form, gas is used to heat water, and the hot water is then passed through a radiator over which air is fanned and, as a result, warmed. The air then passes through ducts to the rooms. Usually, the latter system also provides the hot water service for the home.

The conventional central heating system, in which radiators in the rooms are supplied with water brought from the boiler through comparatively large pipes, is well known. An alternative is the "small-bore" system, whereby very small pipes—usually of ½ in diameter—are used, together with a small pump to circulate the water. These small-bore pipes are not only easier and cheaper to put into new houses, but can also be installed with a minimum of structural alteration in existing houses. Because of the small water content, the radiators heat up very quickly. Notes on the system were given in "At Home" for 8 January.

The warmed-air system utilising the direct heat exchange method has the special advantage that it provides heat in the rooms virtually from the moment it is switched on, whereas units utilising water (either for heat exchange purposes in the unit or to heat radiators in the rooms) take longer to provide a useful heating benefit. On the other hand, the latter type can provide a whole-house hot water service. Whether or not the domestic hot water supply can be drawn from the boiler used in connection with a central heating system depends on the size of the unit and the demands which are to be made upon it.

The number of heat outlets used in conjunction with the heating units depends, naturally, on the size of the unit employed. The warmed-air system, for example, usually has three outlets when installed in a normal three-bedroom house—one in the living room, (from which room air is also drawn for re-heating and recirculation); another in the kitchen; and one on the staircase from which the warmed air enters the upstairs rooms. Each outlet can be opened or shut independently from the heating unit.

In most cases, a thermostat is used to control the heating unit while it is in operation. A time switch is frequently specified by householders, because this enables them to set the heating system to come into operation before they get up in the morning, and switch off automatically at night. In the case of a family who are out all day, the clock control is doubly useful, because the device can be set to switch off and on during the day (usually when they go out and before they return home) in addition to the morning switch-on and the evening switch-off.

These devices help to keep down fuel costs; gas is burned only when heat is required, and a pre-set temperature is maintained, the unit cutting down output (and, of course, consumption) when the temperature is reached. In addition, gas is sold at a special, lower, tariff to a household using the larger quantities which would be taken by a central or warmed-air unit.

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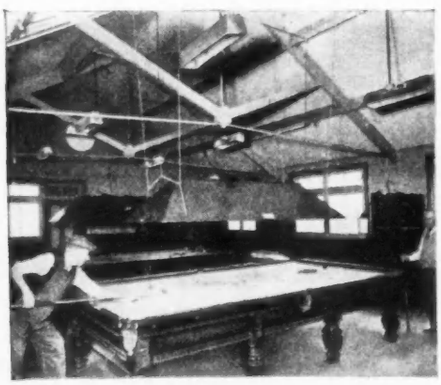

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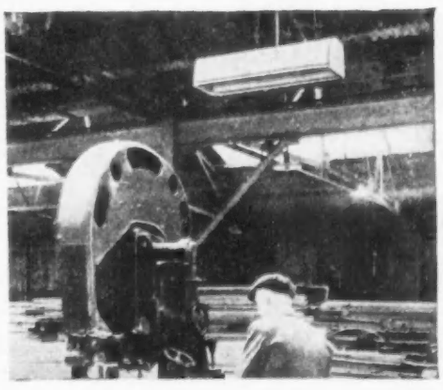

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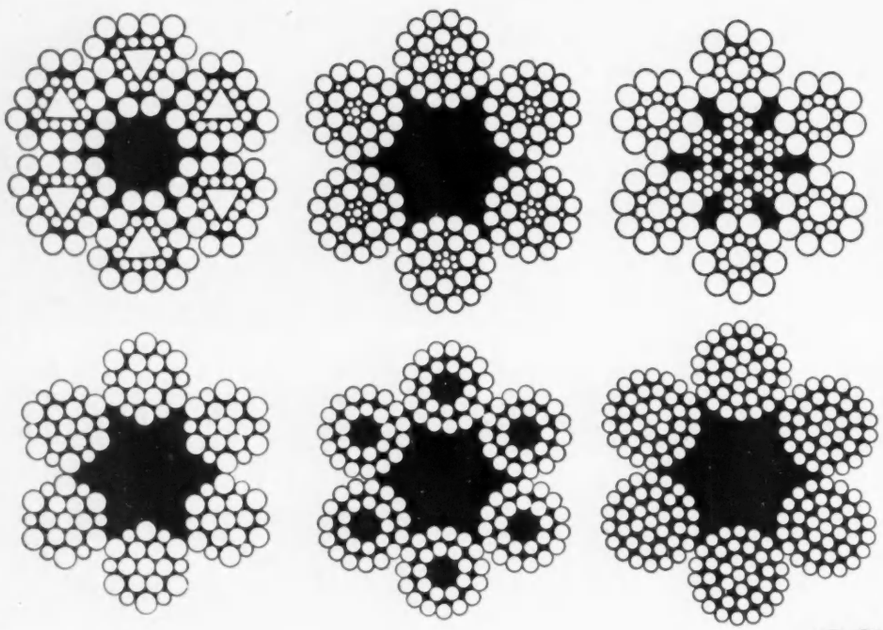

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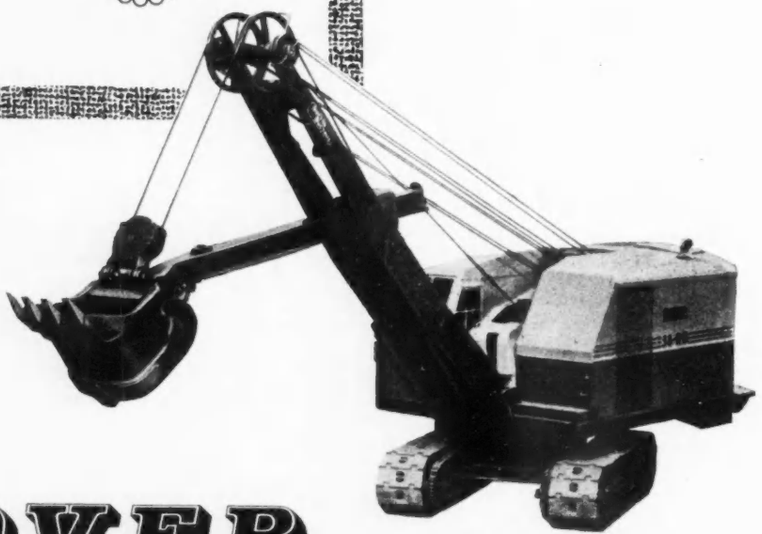

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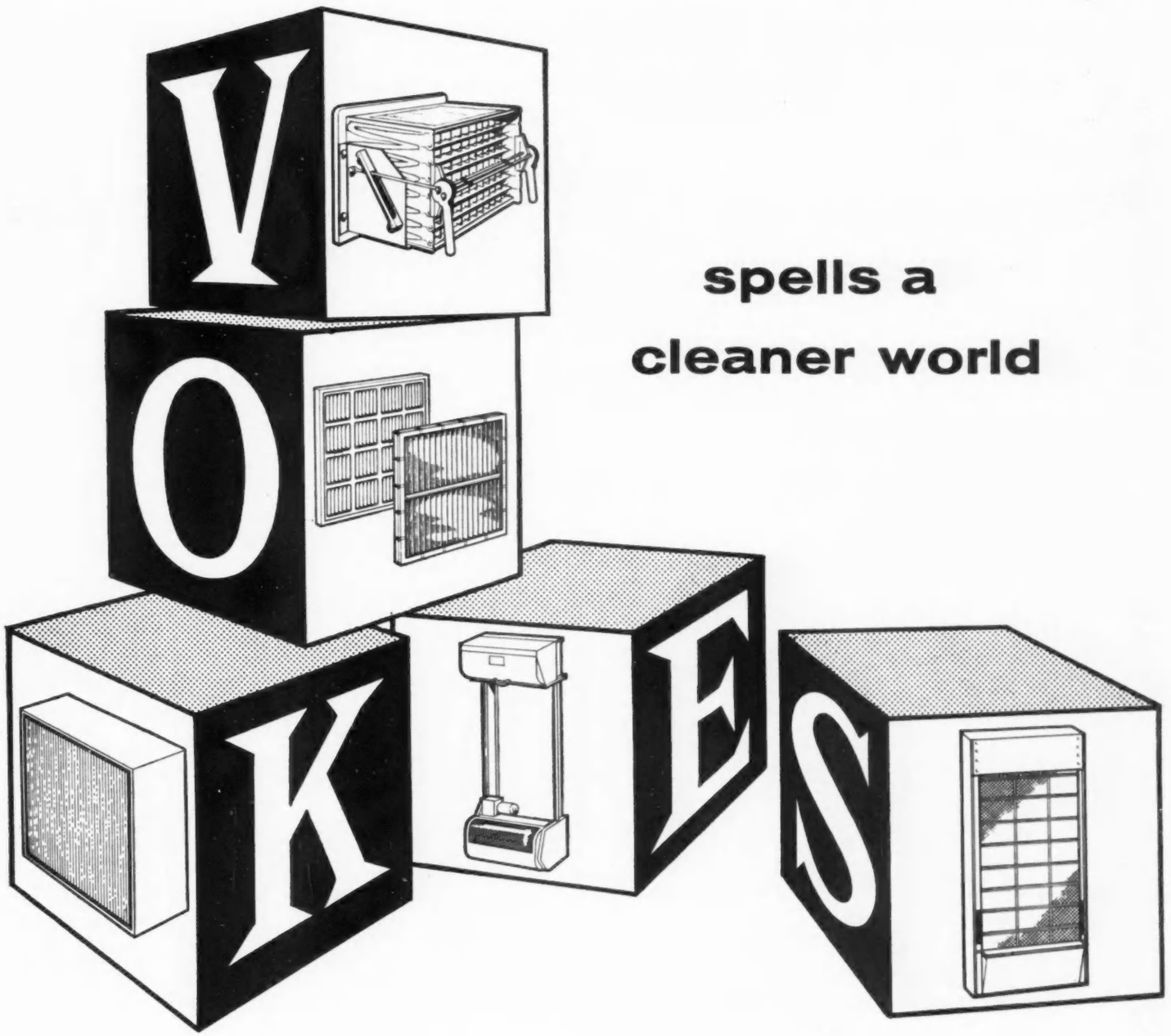

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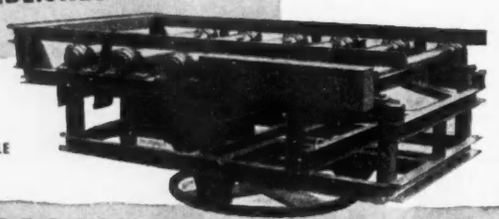

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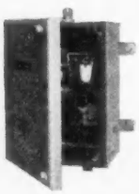

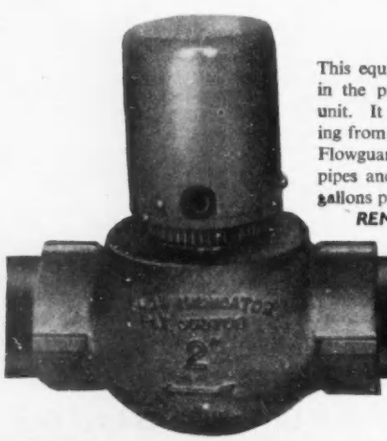

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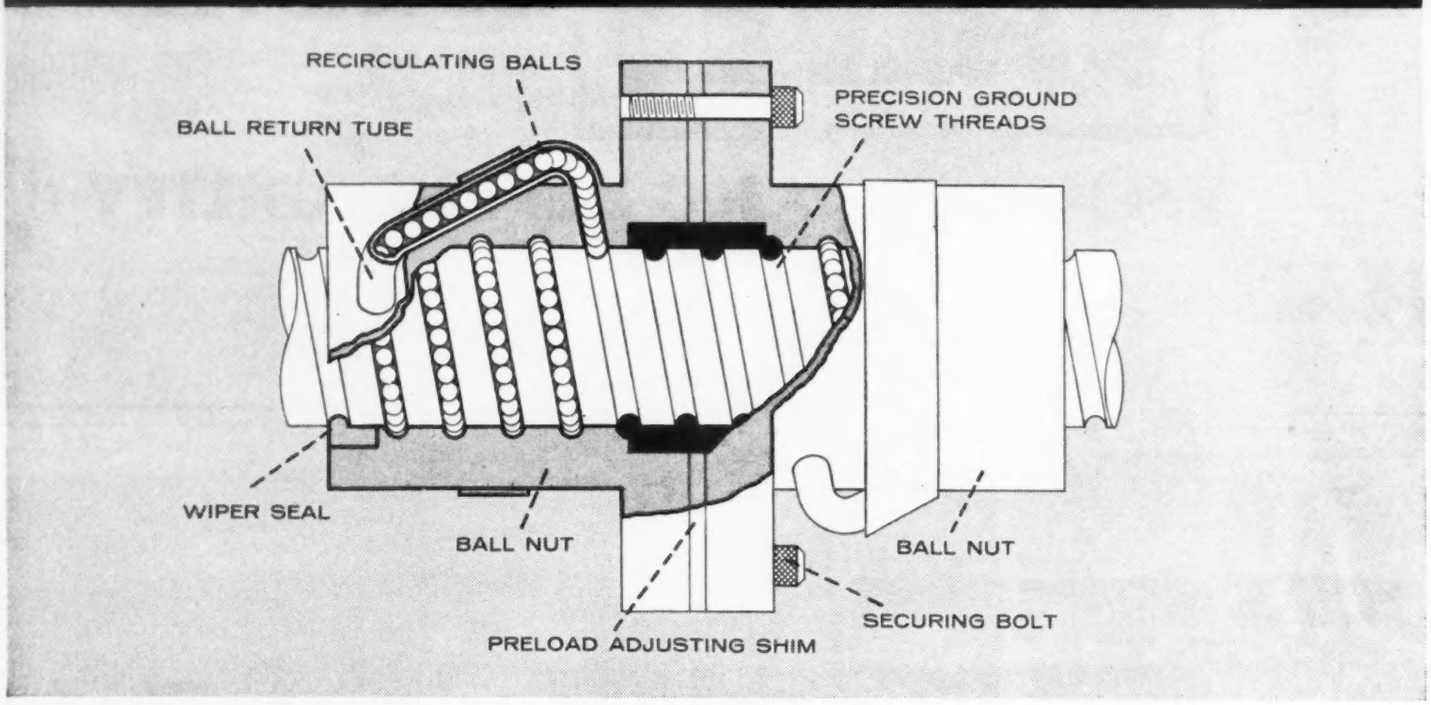

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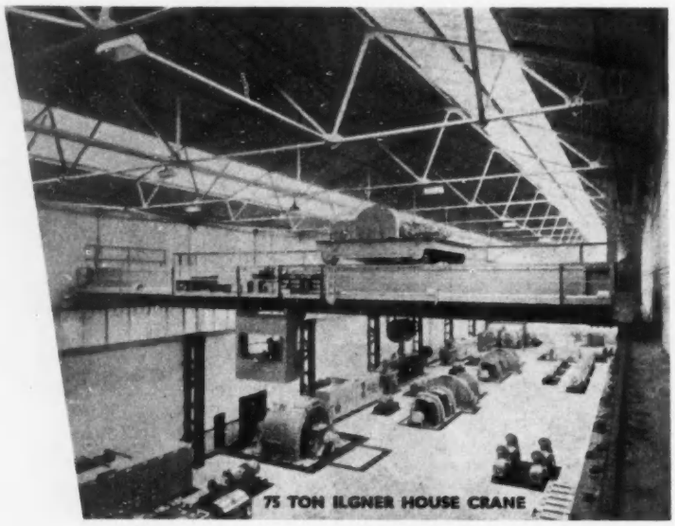
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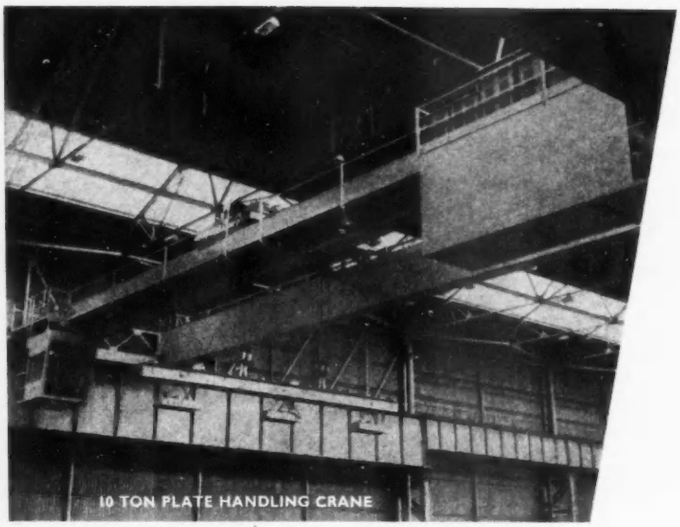
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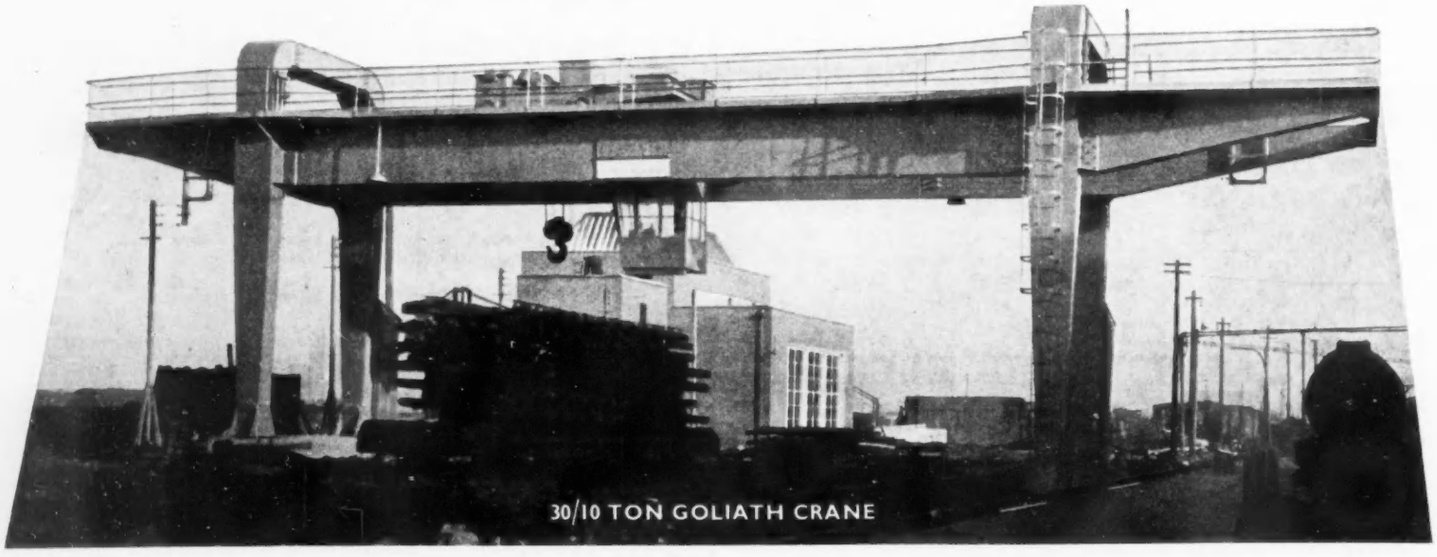
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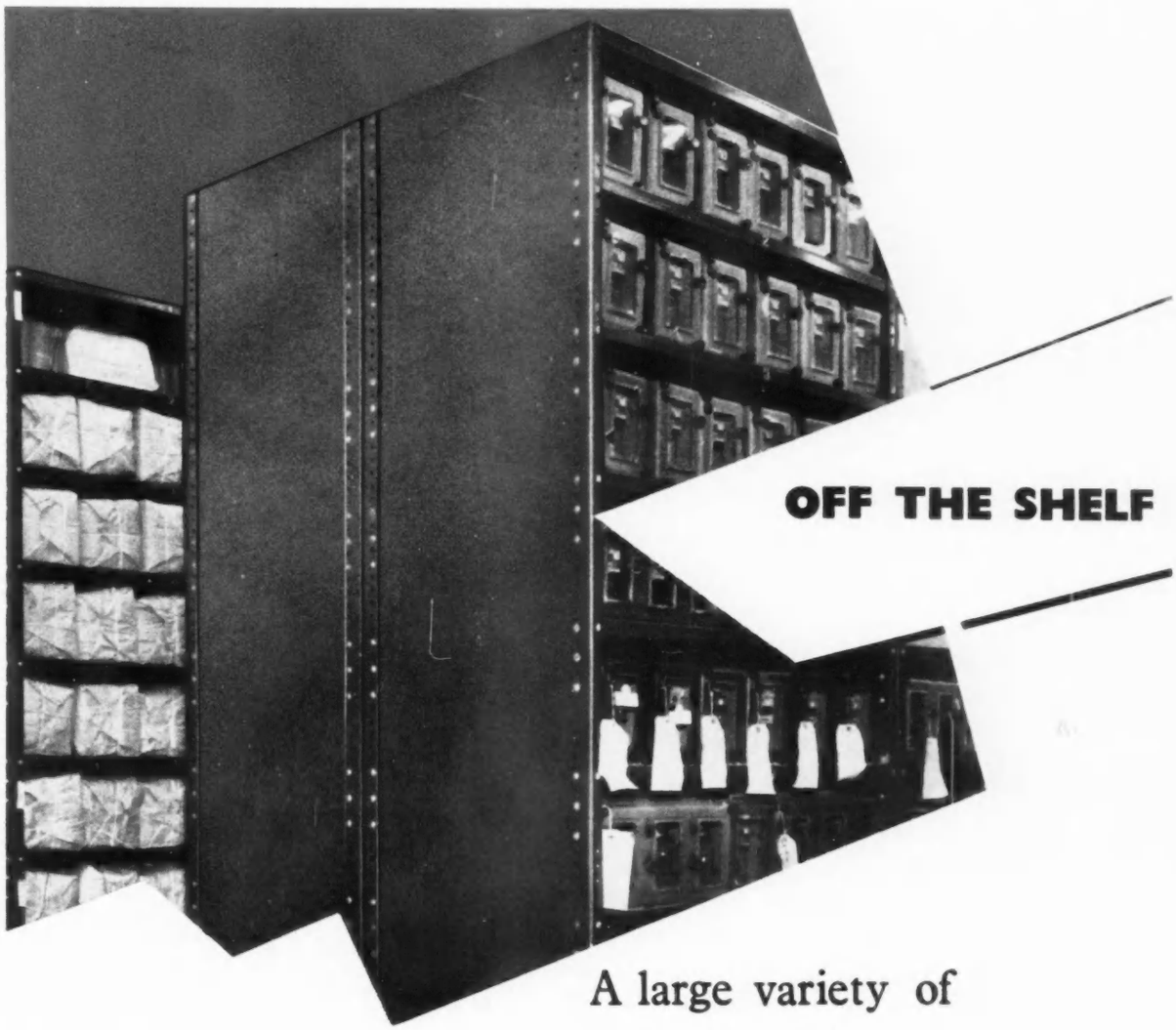

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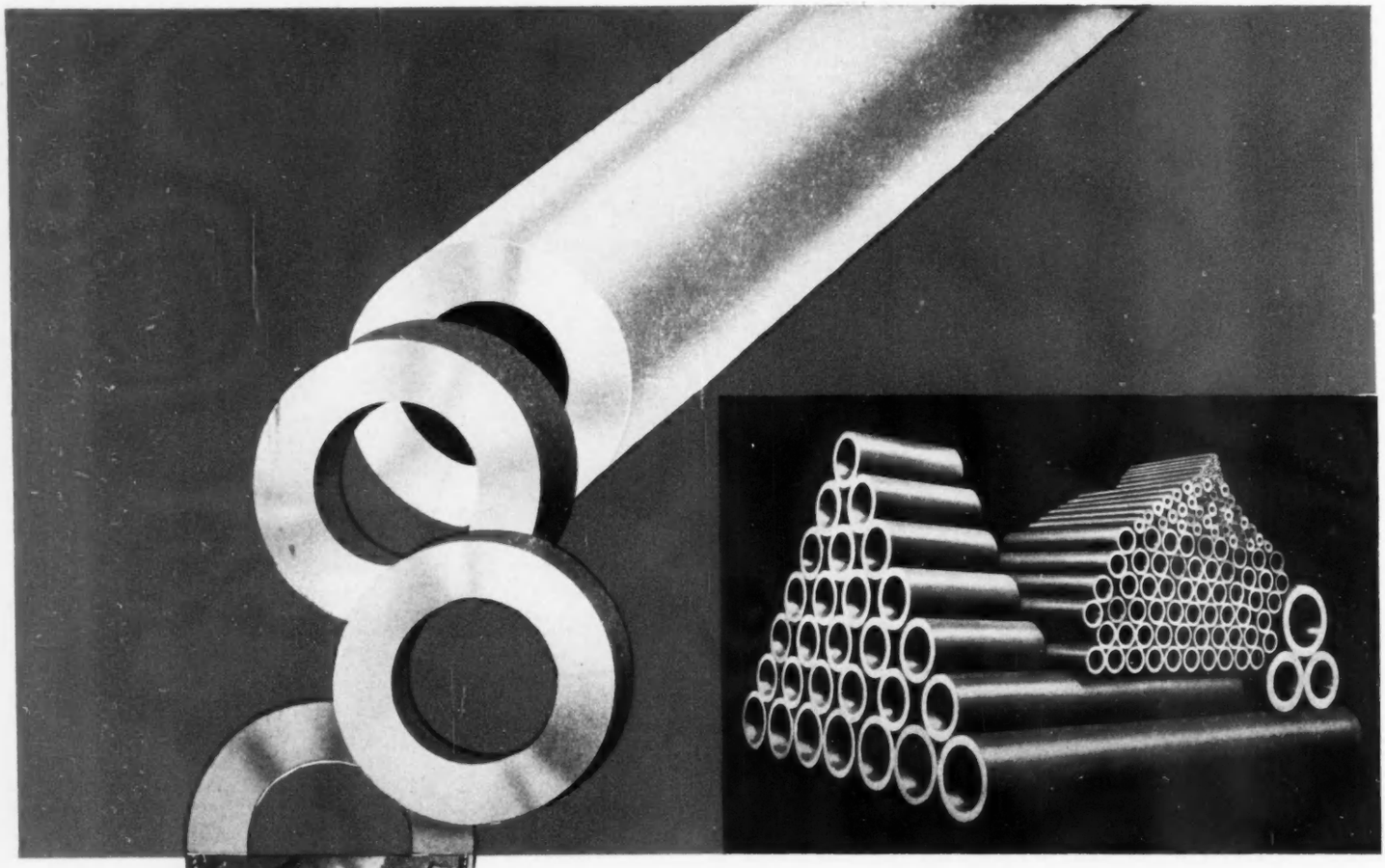

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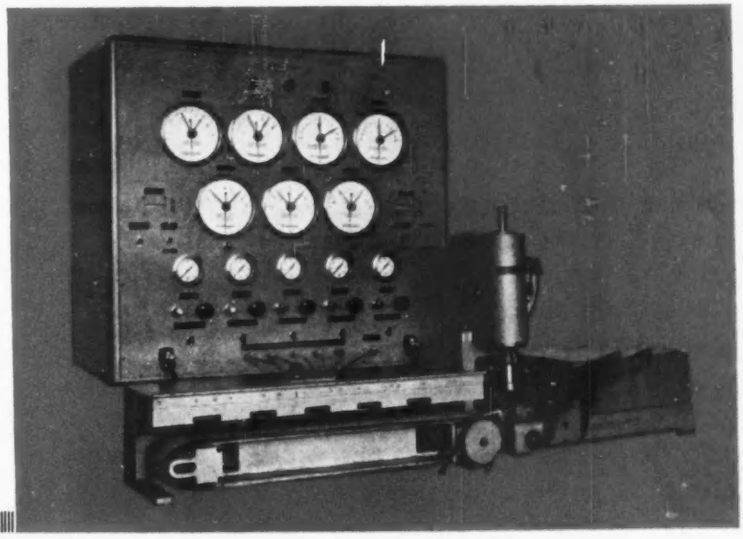

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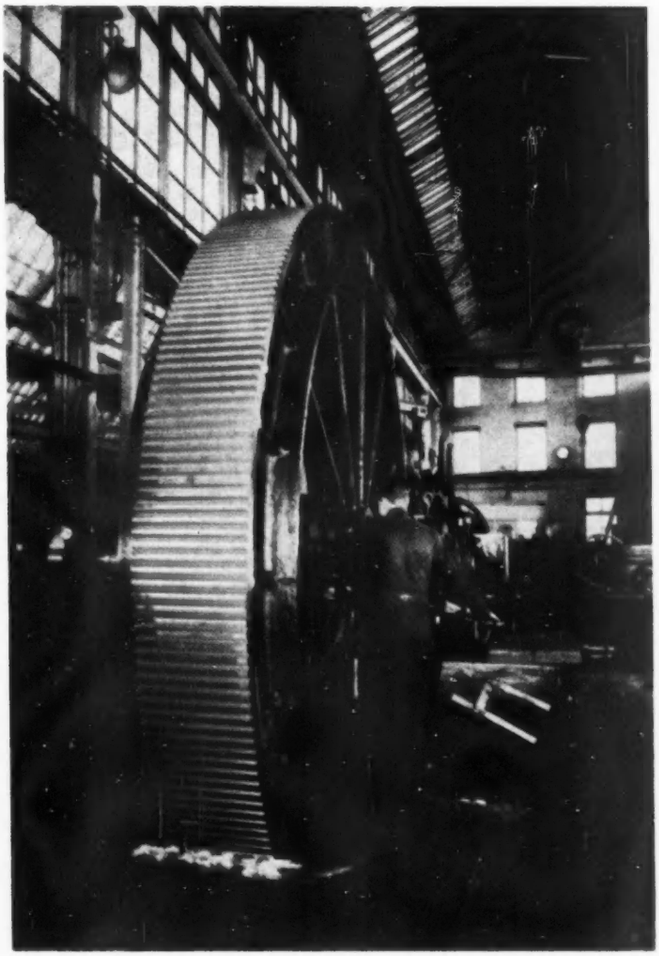

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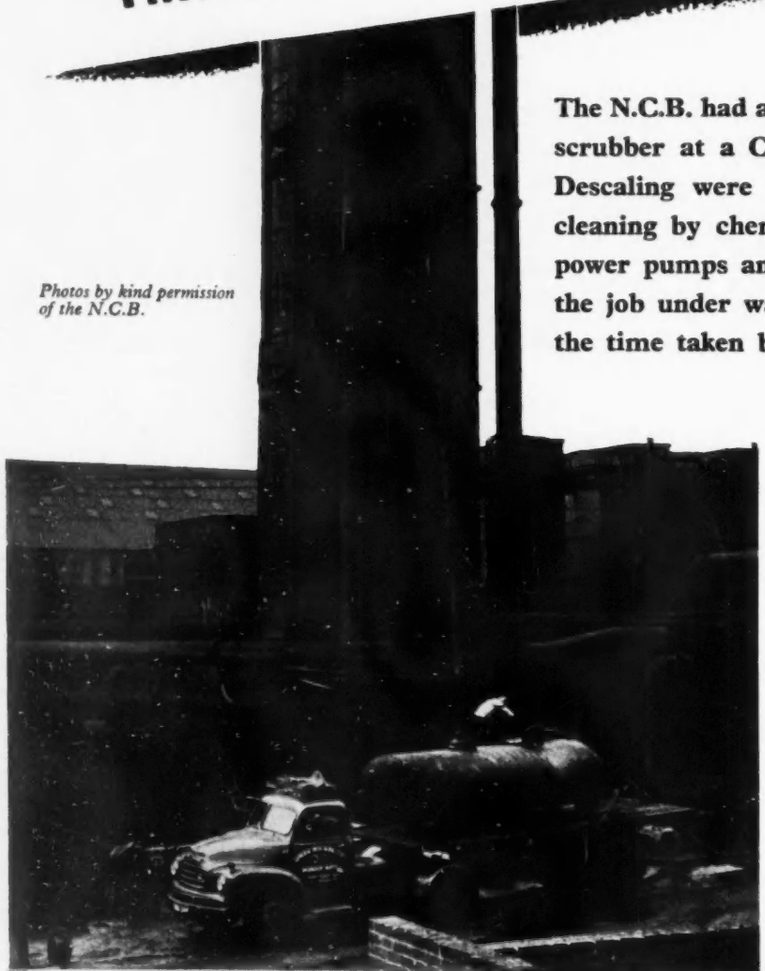

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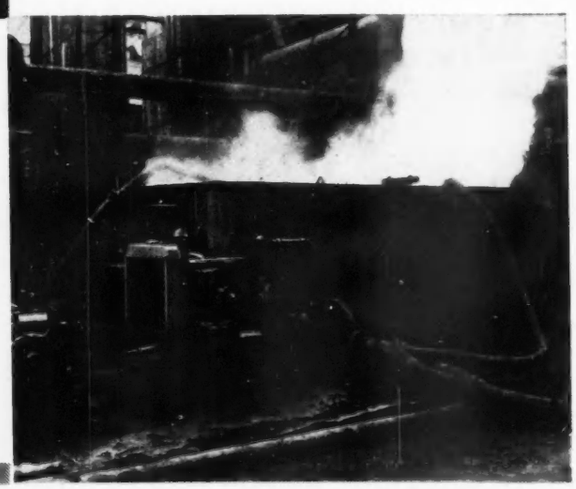

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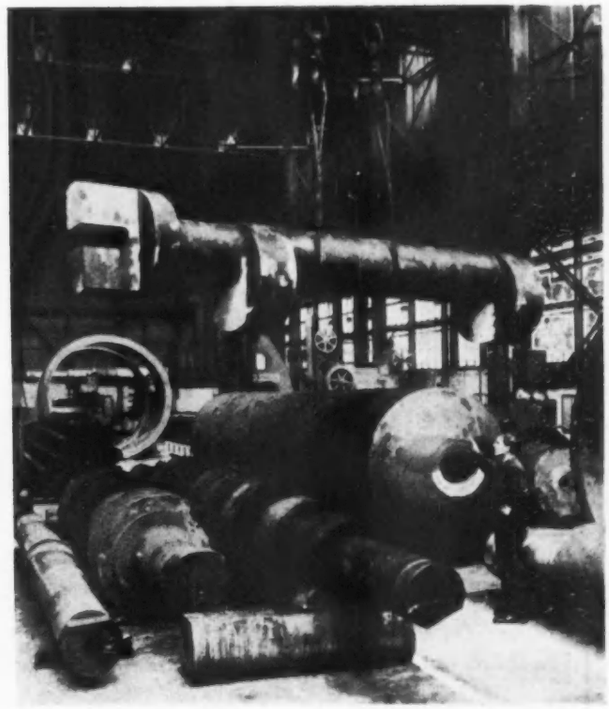

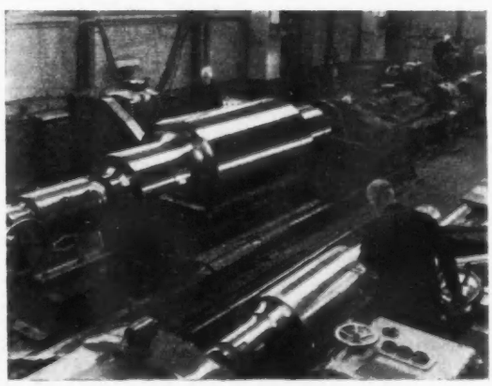

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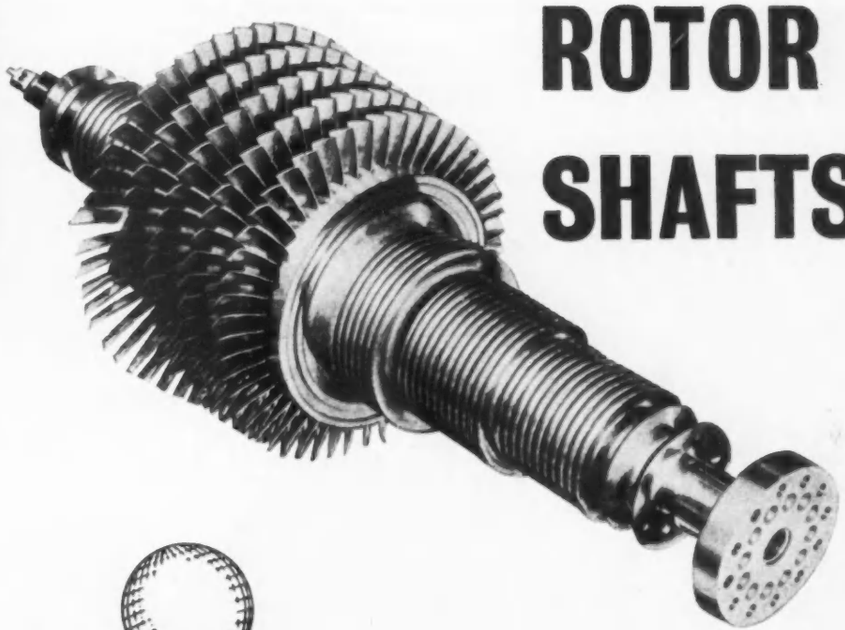

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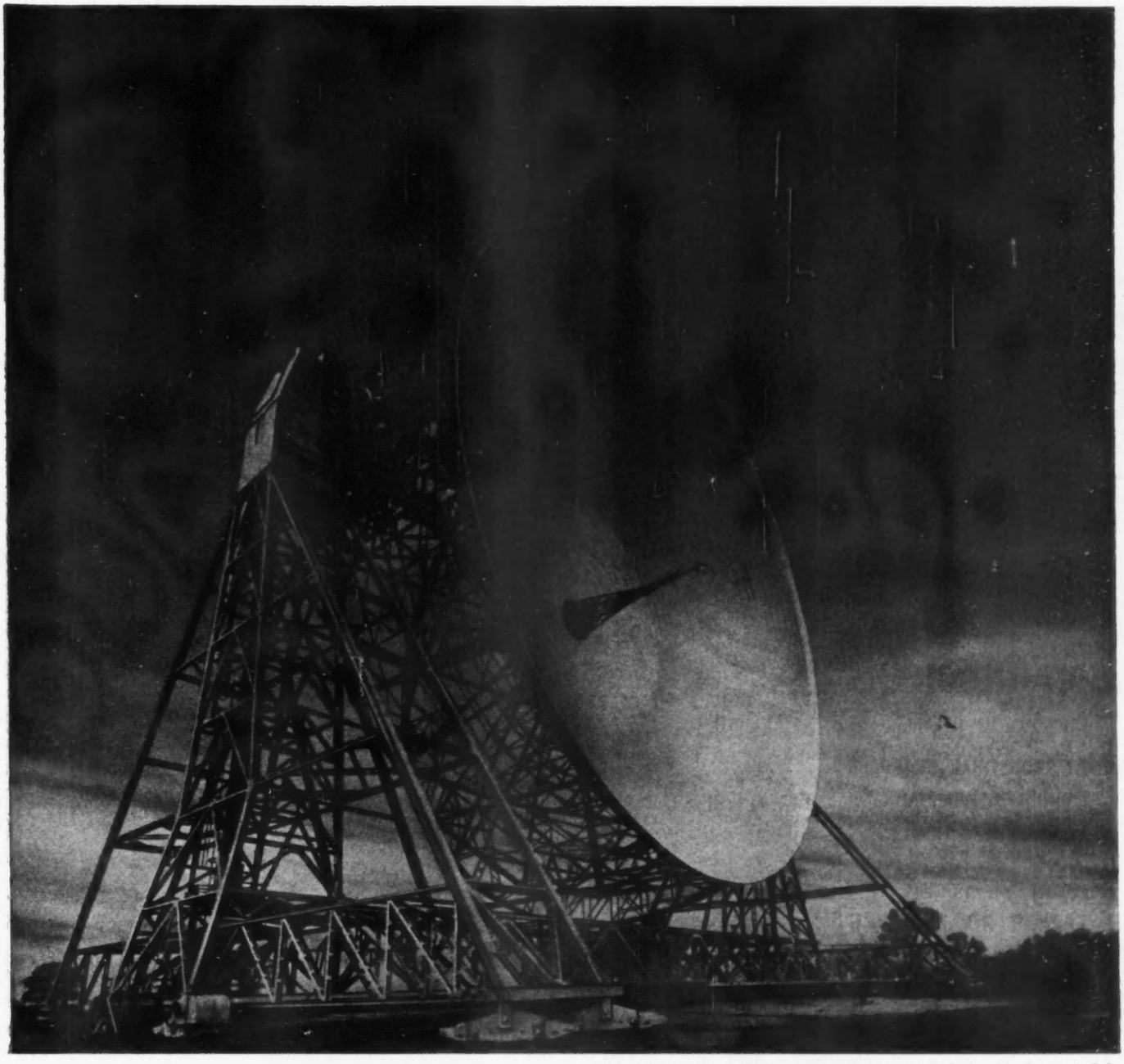

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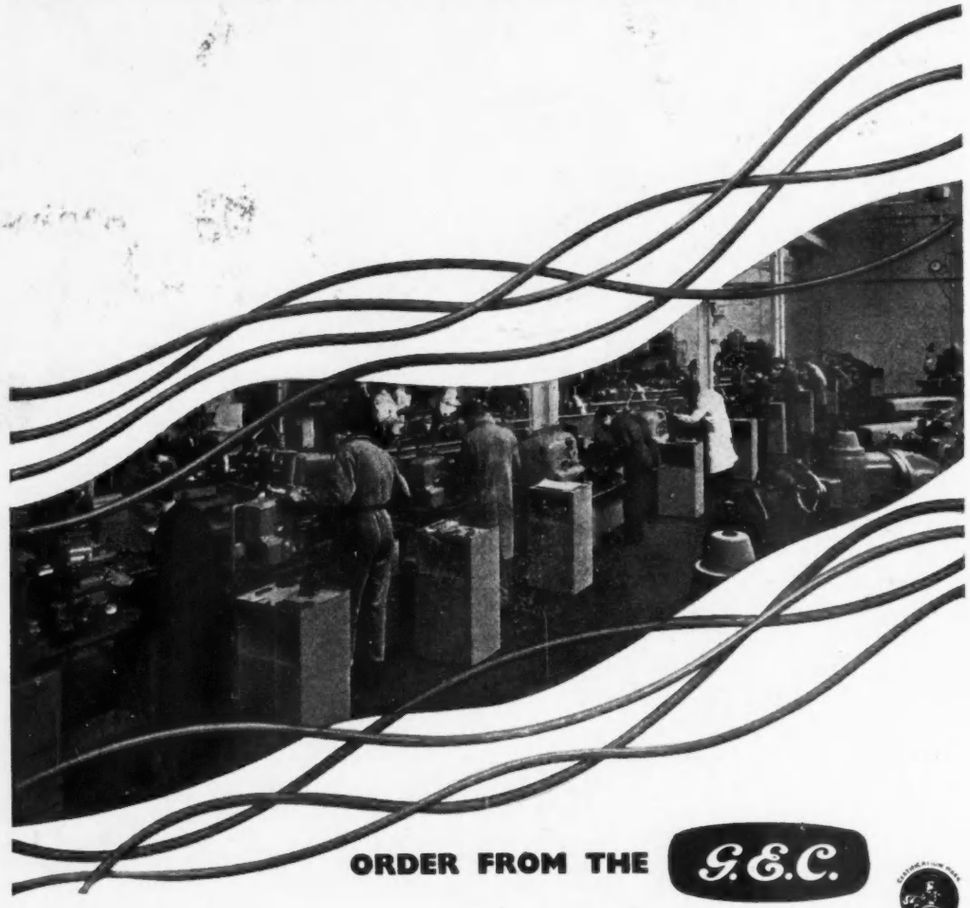

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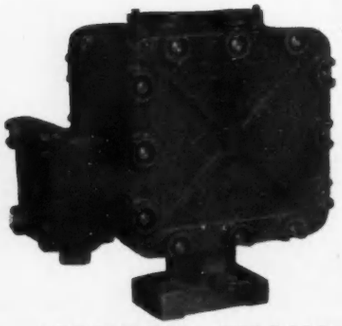

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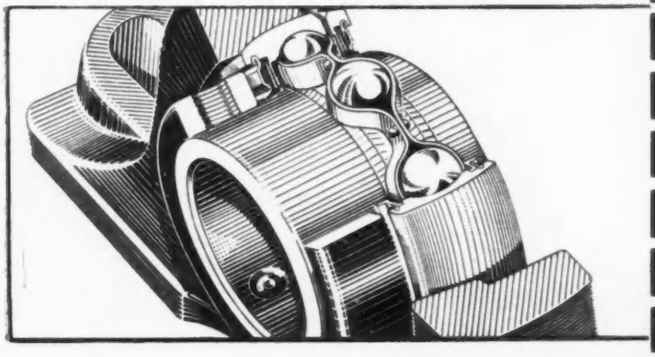

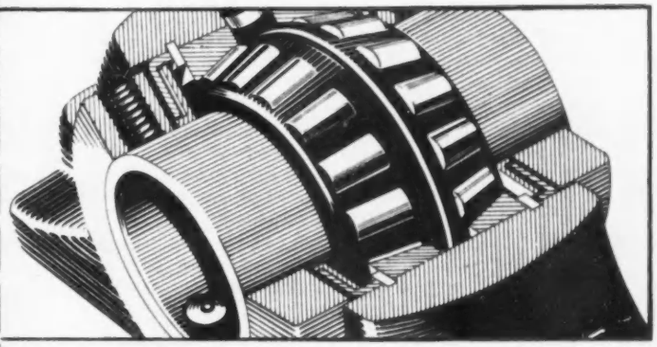

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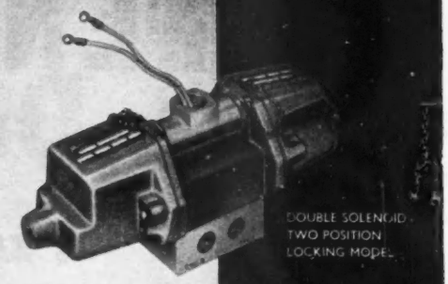

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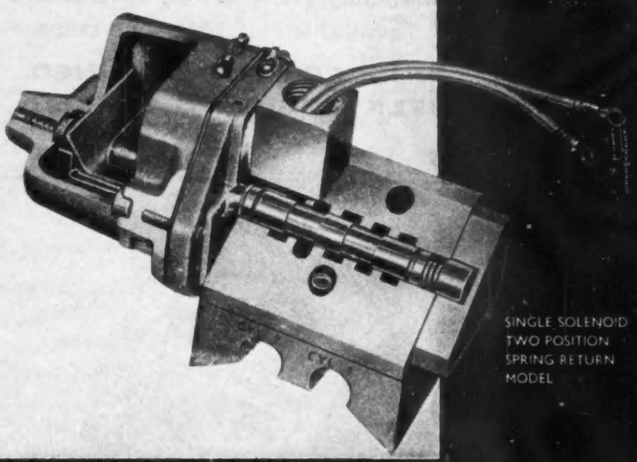

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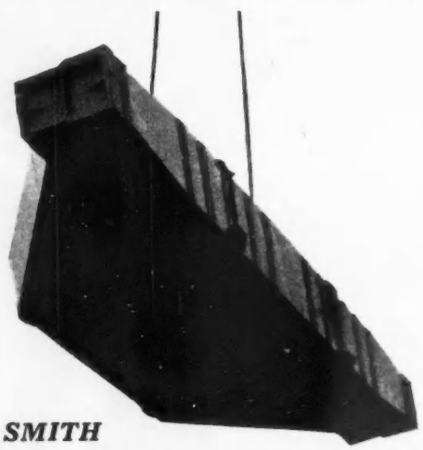

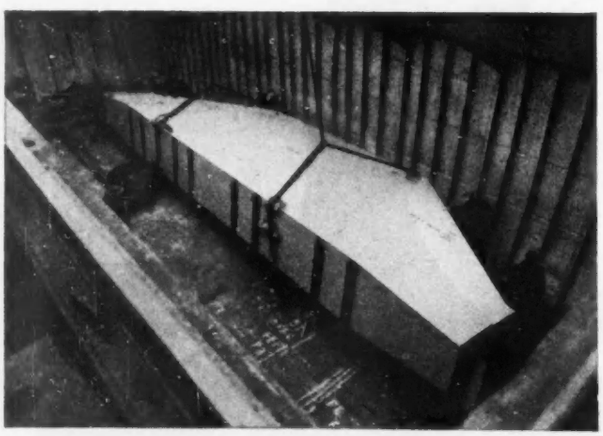

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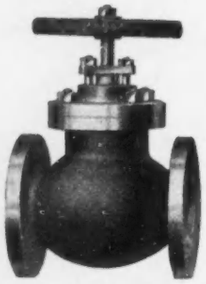

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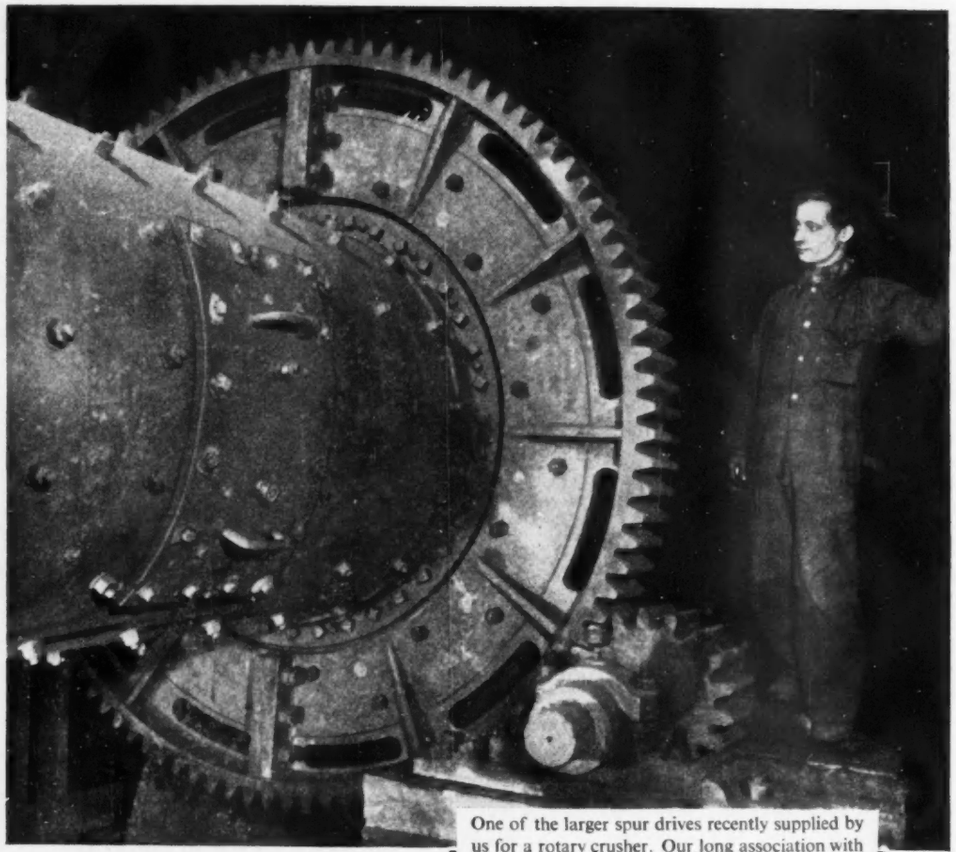

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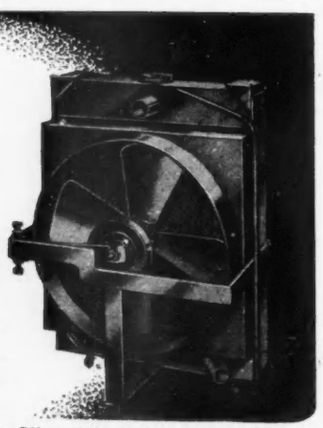

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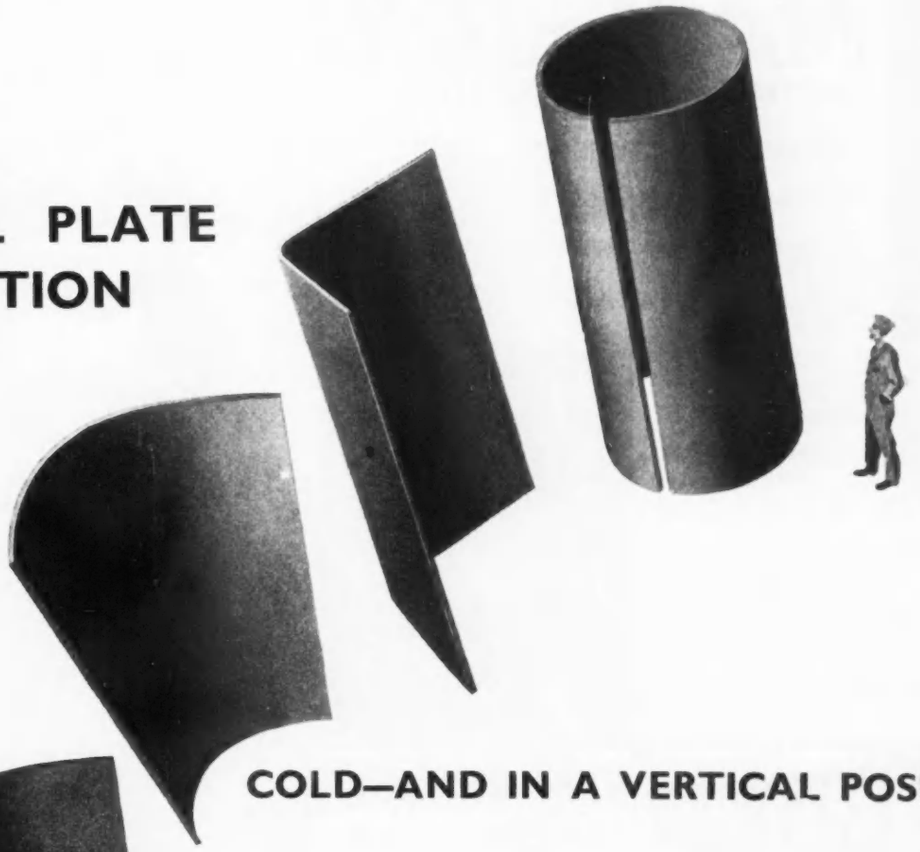

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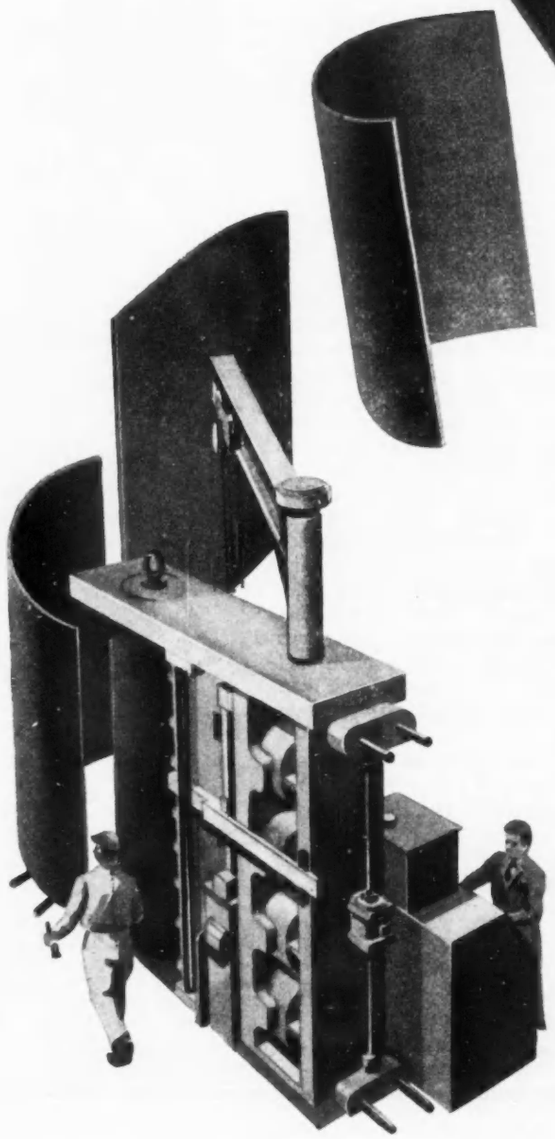

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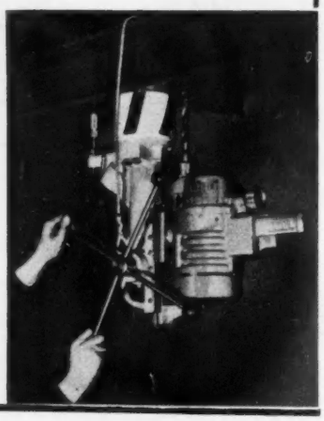

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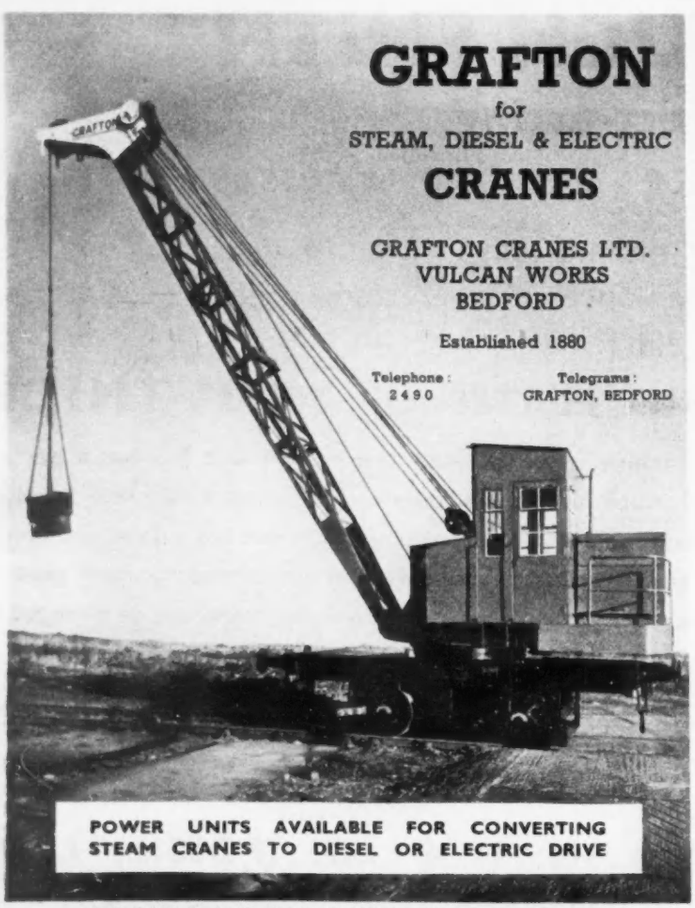

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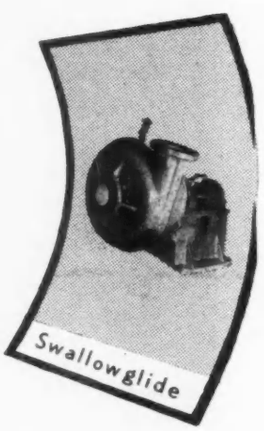

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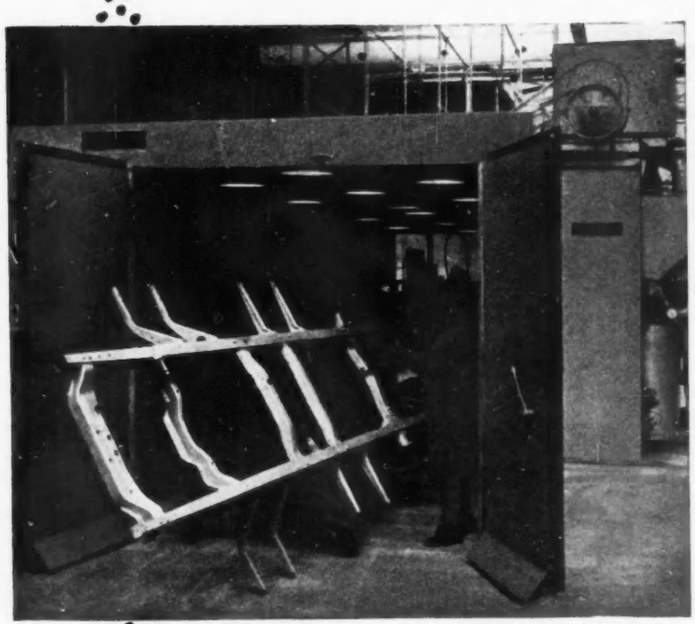

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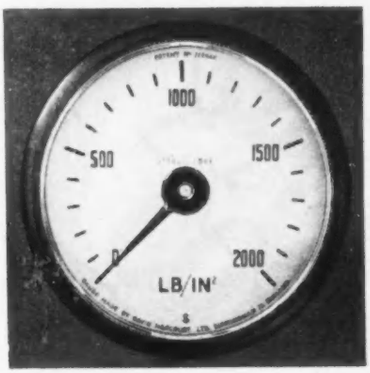

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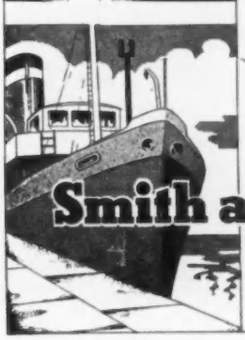

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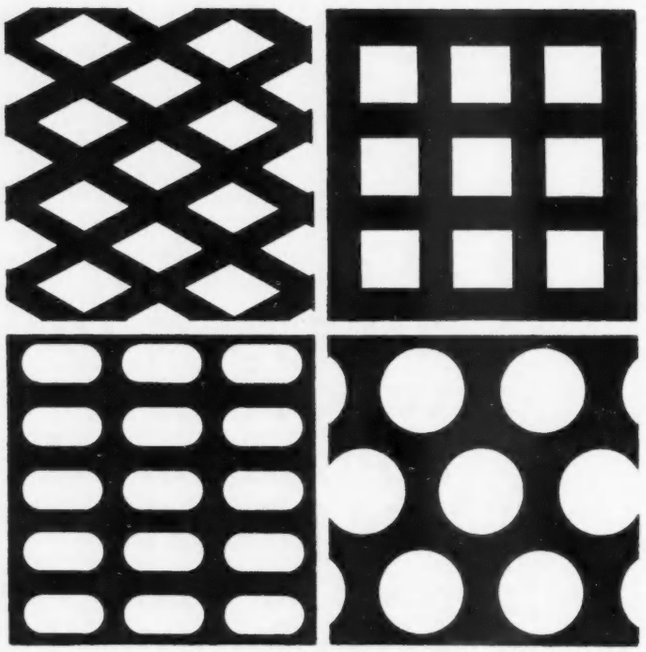

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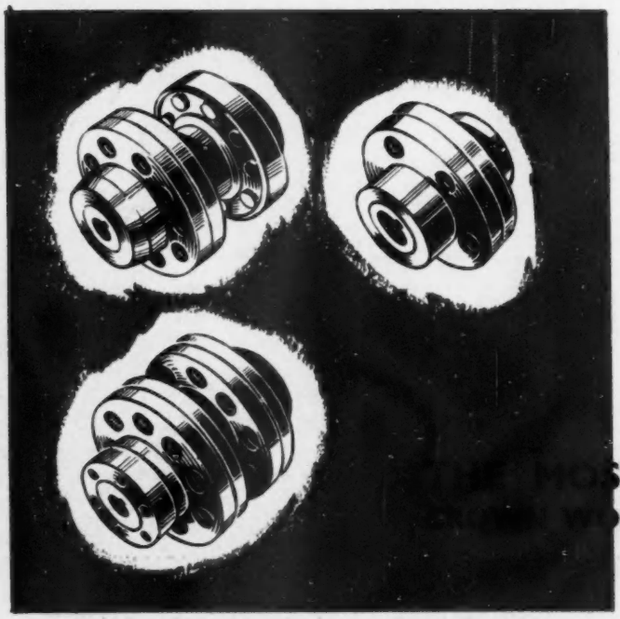

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